The Run II DØ Detector

This talk
- Tevatron Run II
- Luminosity
- SMT
- CFT
- Preshowers
- Calorimeter
- ICD
- Muon
- FPD
- Trigger / DAQ

Leslie Groer

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New York

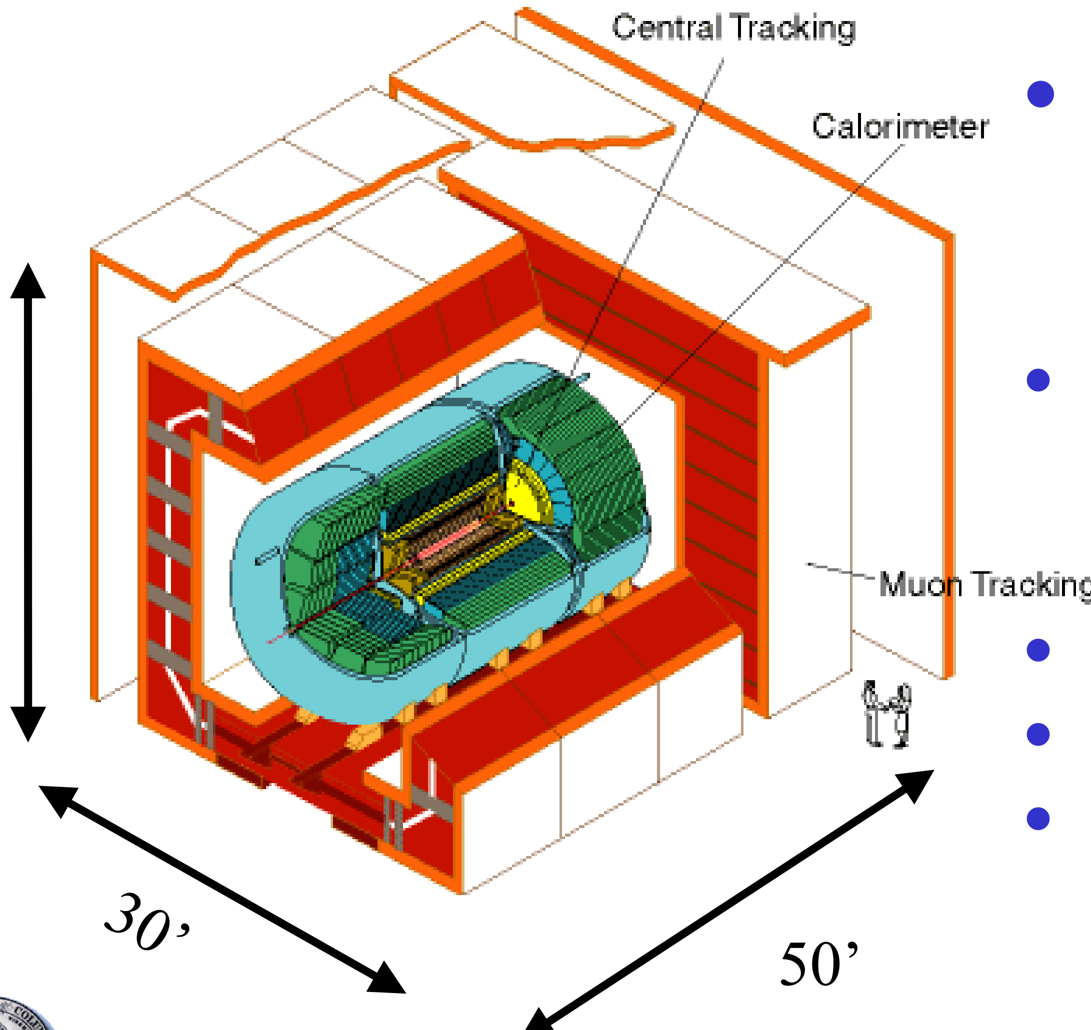
Won't discuss
- Calibrations
- Details of triggers
- Performance metrics
- Physics results
- DAQ
- Operations

University of DØ

March 19, 2003

DØ Run I 1992-96

5000 tons



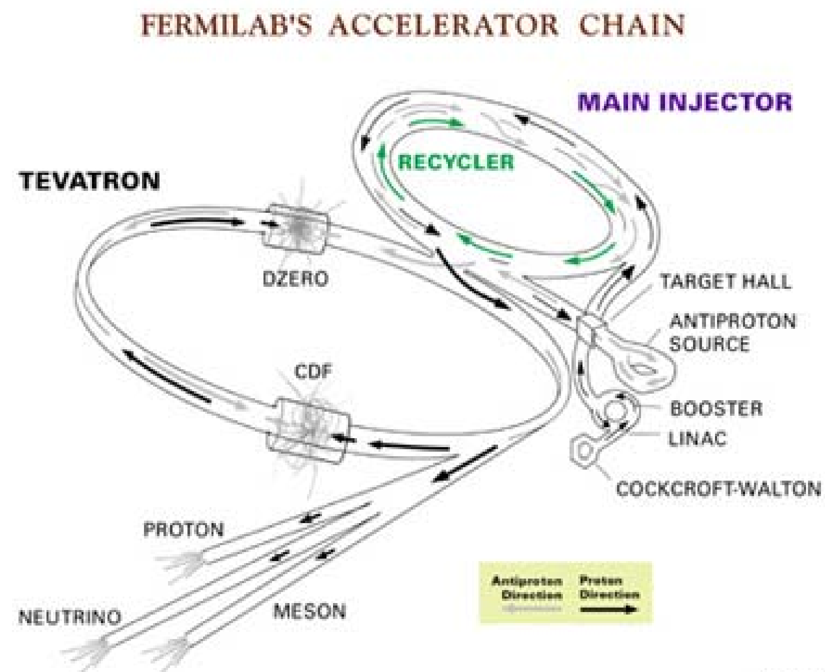
- p-pbar collisions
  $\sqrt{s} = 1.8$ TeV
- $\int L\,dt \sim 120\ pb^{-1}$ delivered to DØ and CDF
  - Peak luminosity
    $1.6 \times 10^{31}\ cm^{-2}\ s^{-1}$
- Lots of physics results
  - Top discovery, W mass, Limits on SUSY, QCD etc etc
- 100+ published papers
- 60+ PhD theses
- Keep strengths for Run II
  - Calorimeter
  - Central Muon

Fermilab Tevatron Upgrade

- Two new machines at FNAL for Run II:
  - Main Injector
    - 150 GeV conventional proton accelerator
    - Increased luminosity
  - Recycler
    - 8 GeV permanent magnet storage ring
    - antiproton stacking and maybe recycling from the collider
- Tevatron Status and Schedule
  - DØ and CDF rolled in January 2001
  - Run II official start March 2001
  - Goal: $\int L\, dt = 2\ fb^{-1}$ by 2005
    $15\ fb^{-1}$+ by LHC physics
  - First p-pbar collisions seen (August 2000)

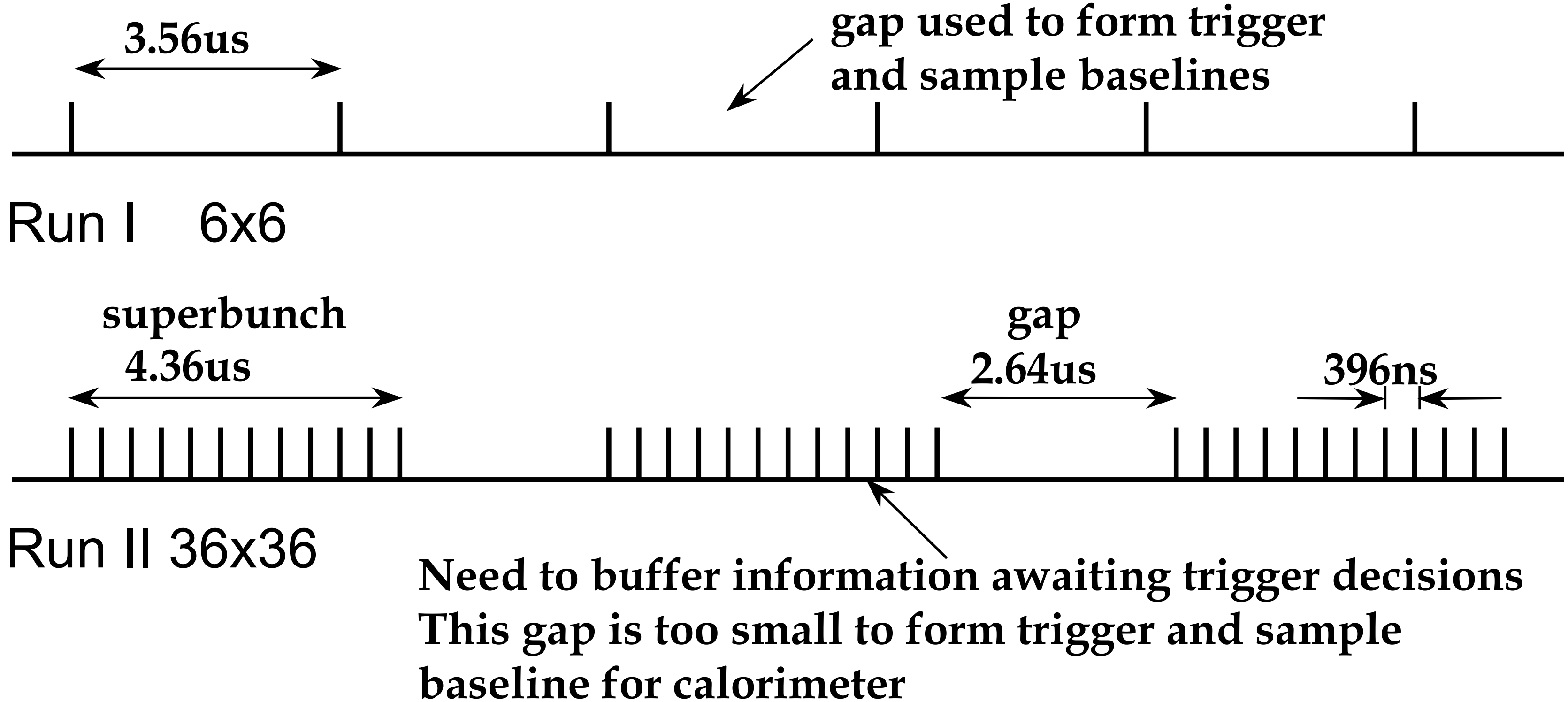
	Run 1b	Run 2a	Run 2b
Bunches in Turn	6×6	36×36	140×103
$\sqrt{s}$ (TeV)	1.8	1.96	1.96
Typical L ($cm^{-2}s^{-1}$)	1.6×10^{30}	8.6×10^{31}	5.2×10^{32}
$\int$ Ldt (pb^{-1}/week)	3.2	17.3	105
Bunch xing (ns)	3500	396	132
Interactions / xing	2.5	2.3	4.8

Run 1 → Run 2a → Run 2b
$0.1\ fb^{-1}$ → $2–4\ fb^{-1}$ → $15\ fb^{-1}$



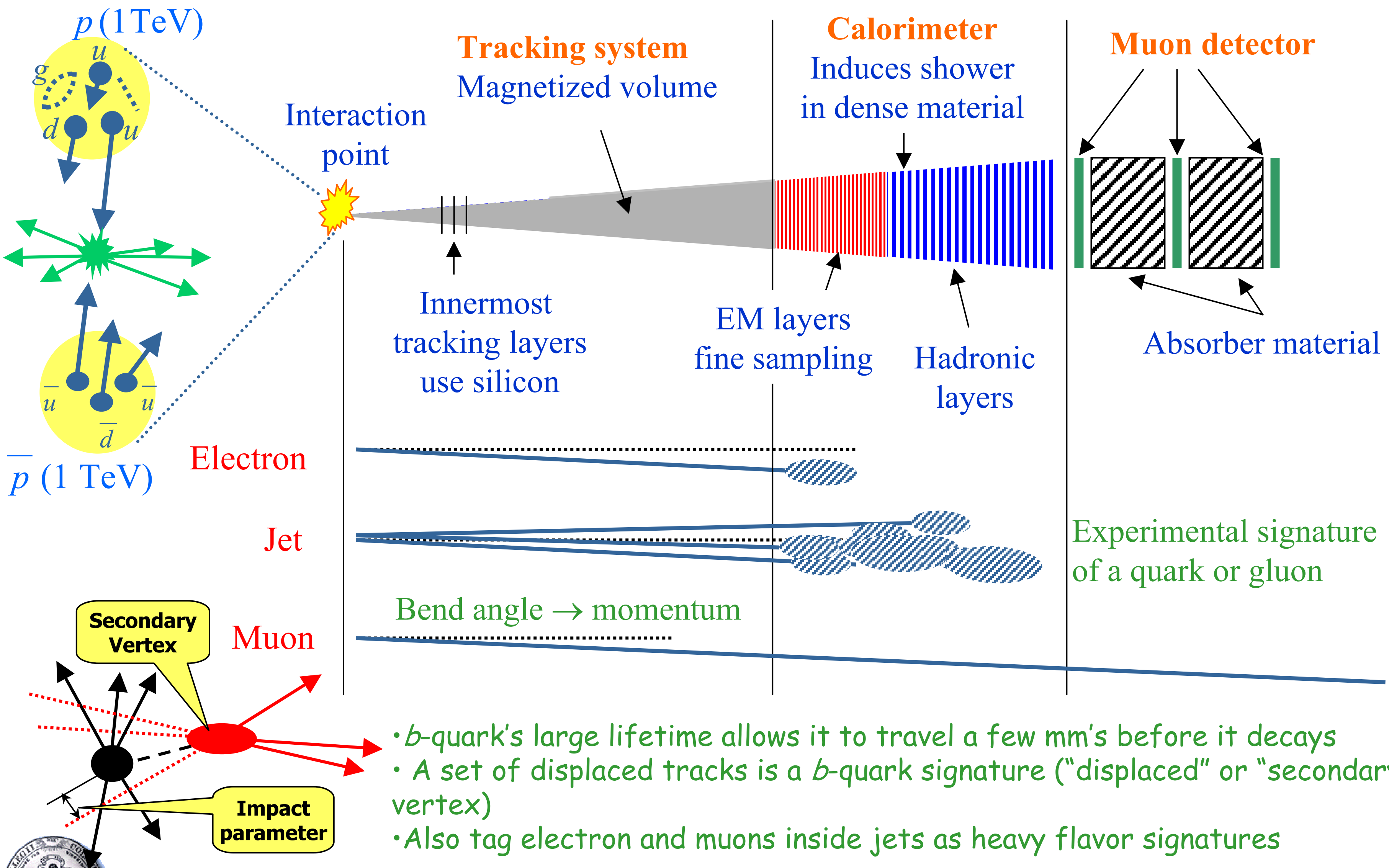
Run II Tevatron Timing

- Bunch structure



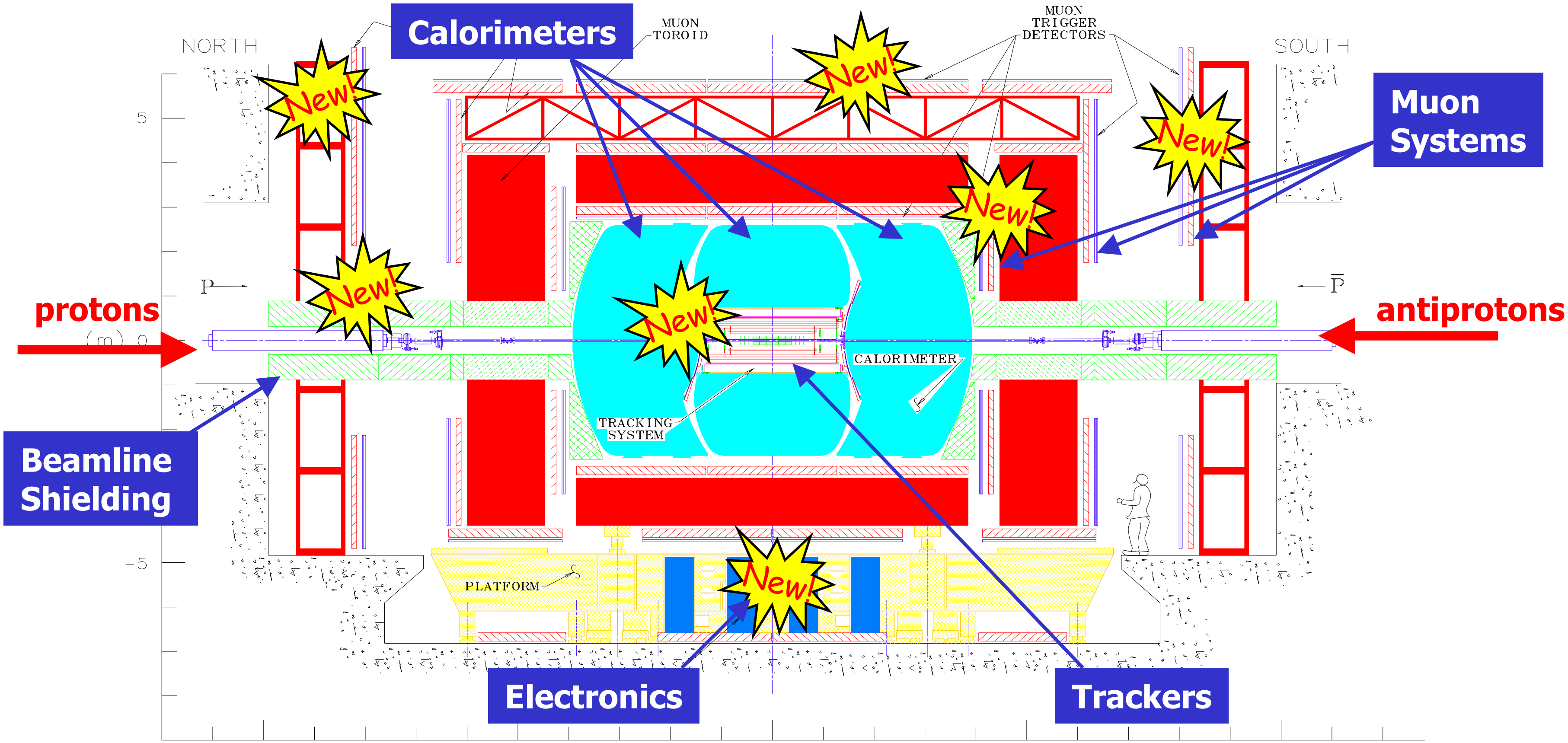
- Design all the electronics, triggers and DAQ to handle bunch structure with a minimum of 132ns between bunches and higher luminosity
- Maintain detector performance from Run I with higher rate, fluxes
  →need better precision, better triggers

Identifying particles in a HEP detector



- *b*-quark's large lifetime allows it to travel a few mm's before it decays
- A set of displaced tracks is a *b*-quark signature ("displaced" or "secondary" vertex)
- Also tag electron and muons inside jets as heavy flavor signatures

The Run 2a DØ Detector



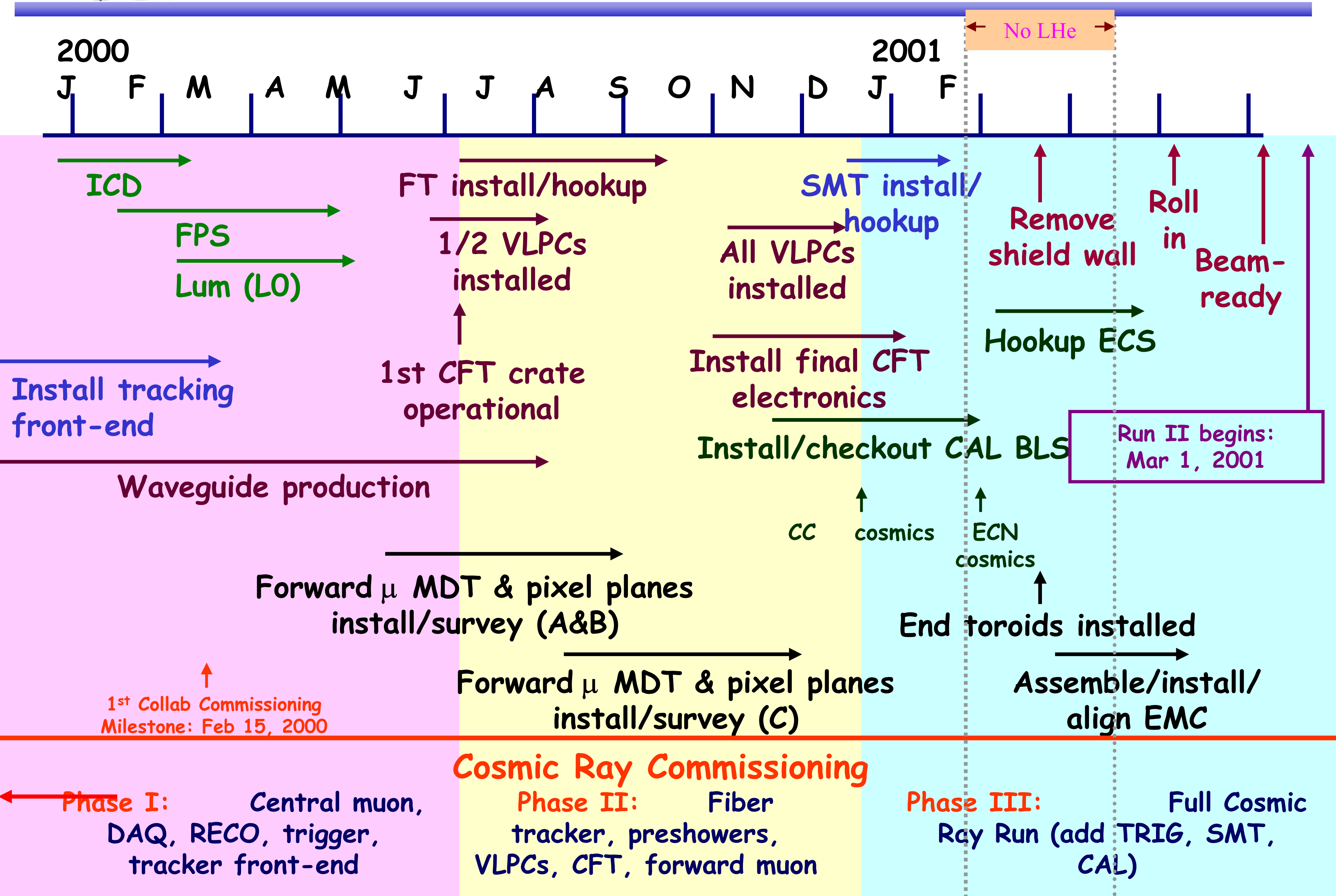
- Silicon Microstrip Tracker (SMT)
- Central Fiber Tracker (CFT)
- Superconducting Solenoid
- Central/Forward Preshowers (PS)
- Inter-Cryostat Detectors (ICD)

- Muon central and forward scintillator
- Muon central propotional drift tubes (PDT)
- Muon forward mini-drift tubes (MDT)
- Forward Proton Detector (FPD)
- Shielding
- Front-end readout electronics, trigger, DAQ,…

Detector Comparisons

		DØ – Run I	DØ – Run II	CDF – Run II	
Field	T	0	2.0	1.4	Tracking
η accept		<3.0	<3.0(Si) ; <1.7 (CFT)	<2.0(Si) ; <1.0(COT)	
Radii	cm	3.7-75	2.8-10.0(Si) ; <52(CFT)	1.6-10.7(Si) ; <132(COT)	
$\delta P_T/P_T$	%	—	$2 \oplus 0.2 p_t$	$0.7 \oplus 0.1 p_t$	
Imp par	μm	—	$13 \oplus 50/p_t$	$6 \oplus 22/p_t$	
Prim Vtx	μm		15-30($r\varphi$)	10-35($r\varphi$)	
Sec Vtx	μm	—	40($r\varphi$) ; 80(rz)	14($r\varphi$) ; 50(rz)	
Mass res ($J/\rightarrow\mu\mu$)	MeV	—	27	16	
PID			PreShower	dE/dx,TOF	
η accept		<4.0		<3.6	Calo
$\Delta\eta\times\Delta\varphi$		0.1×0.1		0.1×0.26	
EM res	%	$14/\sqrt{E}$		$16/\sqrt{E}$	
Jet res	%	$80/\sqrt{E}$		$80/\sqrt{E}$	
η accept		<3.6	<2.0	<1.5	Muon
φ cover		90%	increase scint	80% (cen)	
Shield	λ_I	12-18	beam shielding	5.5-20	
Standalone $\delta P/P$	%	$18 \oplus 0.3p$		—	

DØ Timeline



2000
2001
J F M A M J J A S O N D J F
No LHe
ICD
FPS
Lum (L0)
FT install/hookup
1/2 VLPCs installed
1st CFT crate operational
SMT install/ hookup
All VLPCs installed
Install final CFT electronics
Install/checkout CAL BLS
Remove shield wall
Roll in
Beam-ready
Hookup ECS
Run II begins: Mar 1, 2001
Install tracking front-end
Waveguide production
CC
cosmics
ECN cosmics
Forward μ MDT & pixel planes install/survey (A&B)
End toroids installed
1st Collab Commissioning Milestone: Feb 15, 2000
Forward μ MDT & pixel planes install/survey (C)
Assemble/install/ align EMC
Cosmic Ray Commissioning
Phase I: Central muon, DAQ, RECO, trigger, tracker front-end
Phase II: Fiber tracker, preshowers, VLPCs, CFT, forward muon
Phase III: Full Cosmic Ray Run (add TRIG, SMT, CAL)

The DØ Detector rolled in…

DØ detector installed in the Collision Hall, January 2001 – still some cabling to be done

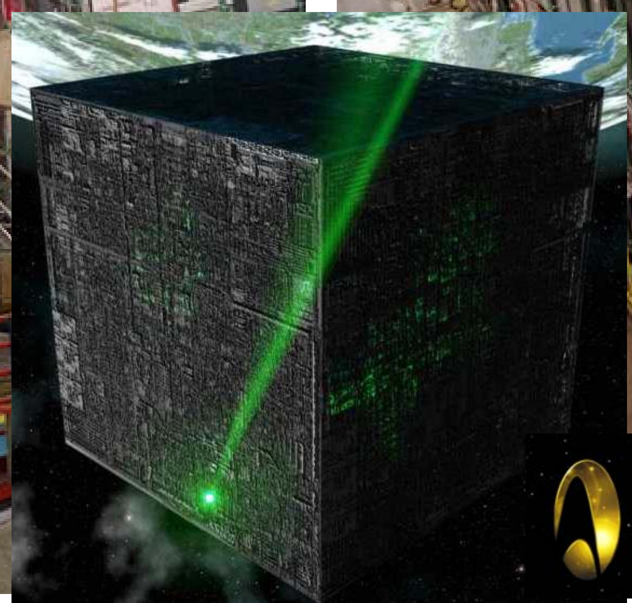
The DØ Collaboration ready for action

The work of many people…

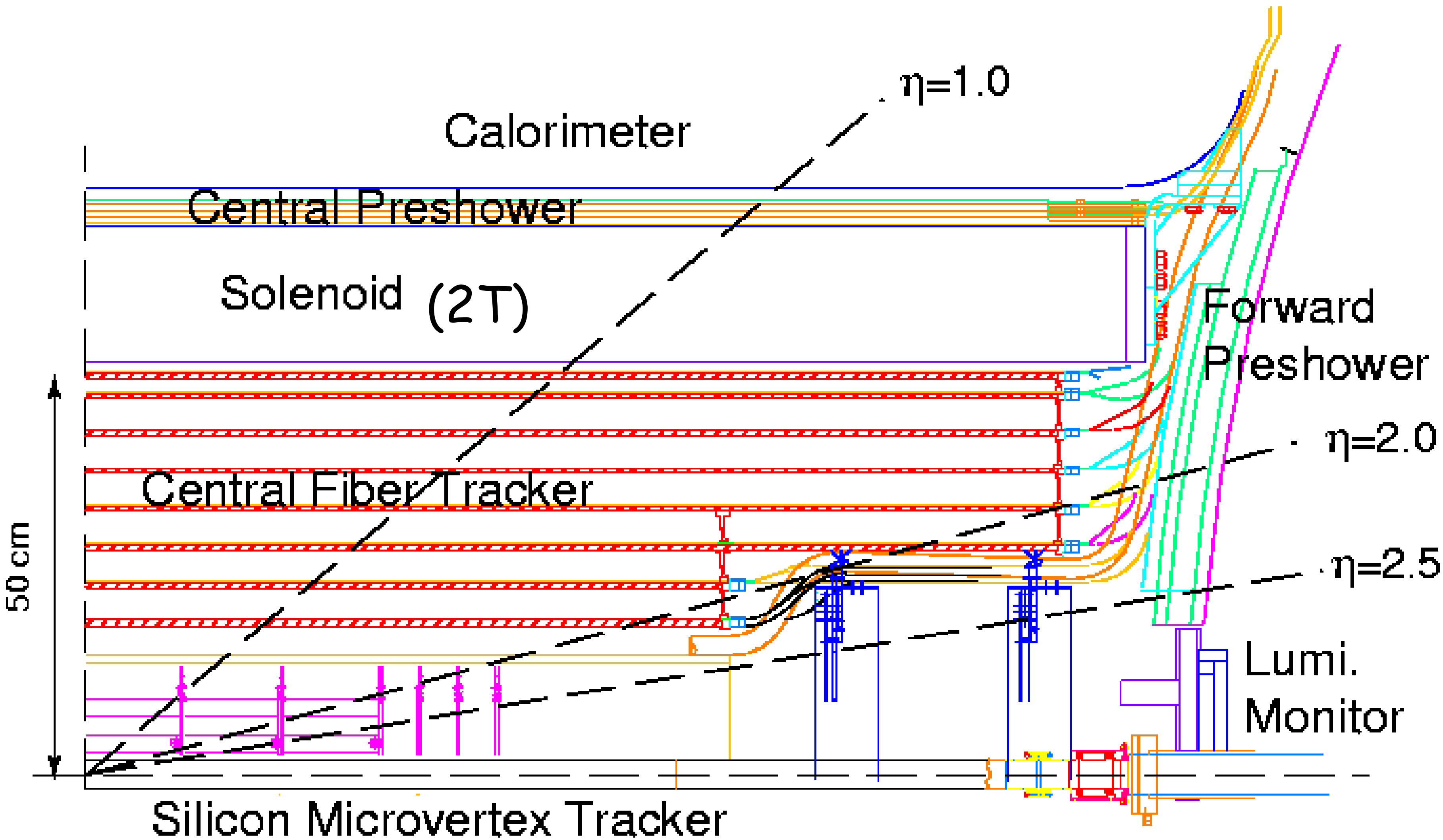
The DØ detector was built and is operated by an international collaboration of
> 650 physicists,
76 institutions (40 non-US)
from 18 nations

> 50% non-USA
~ 120 graduate students

The DØ "Cube"

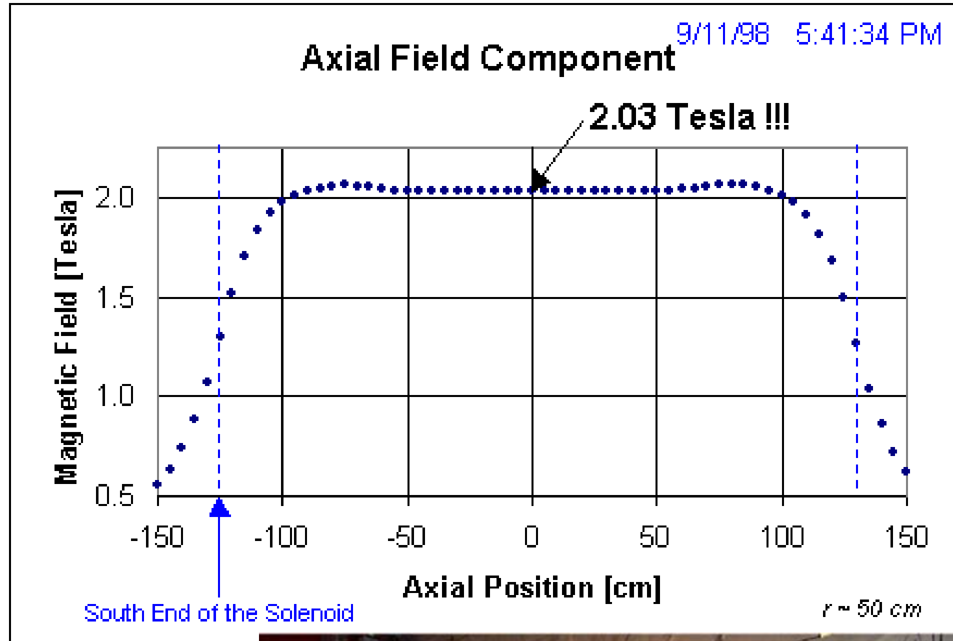


Inner Tracking Volume



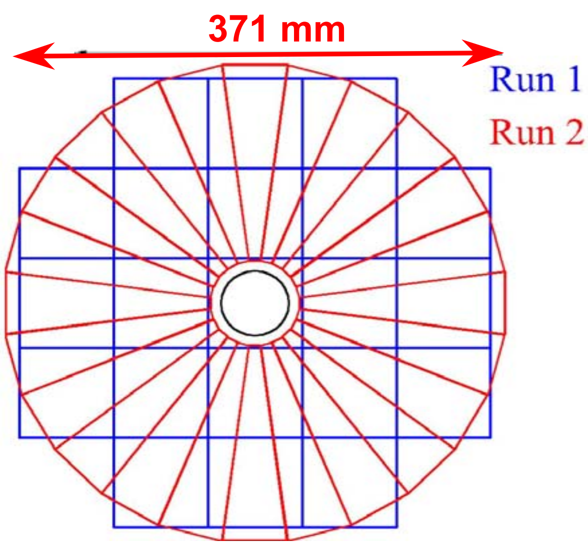
Solenoid

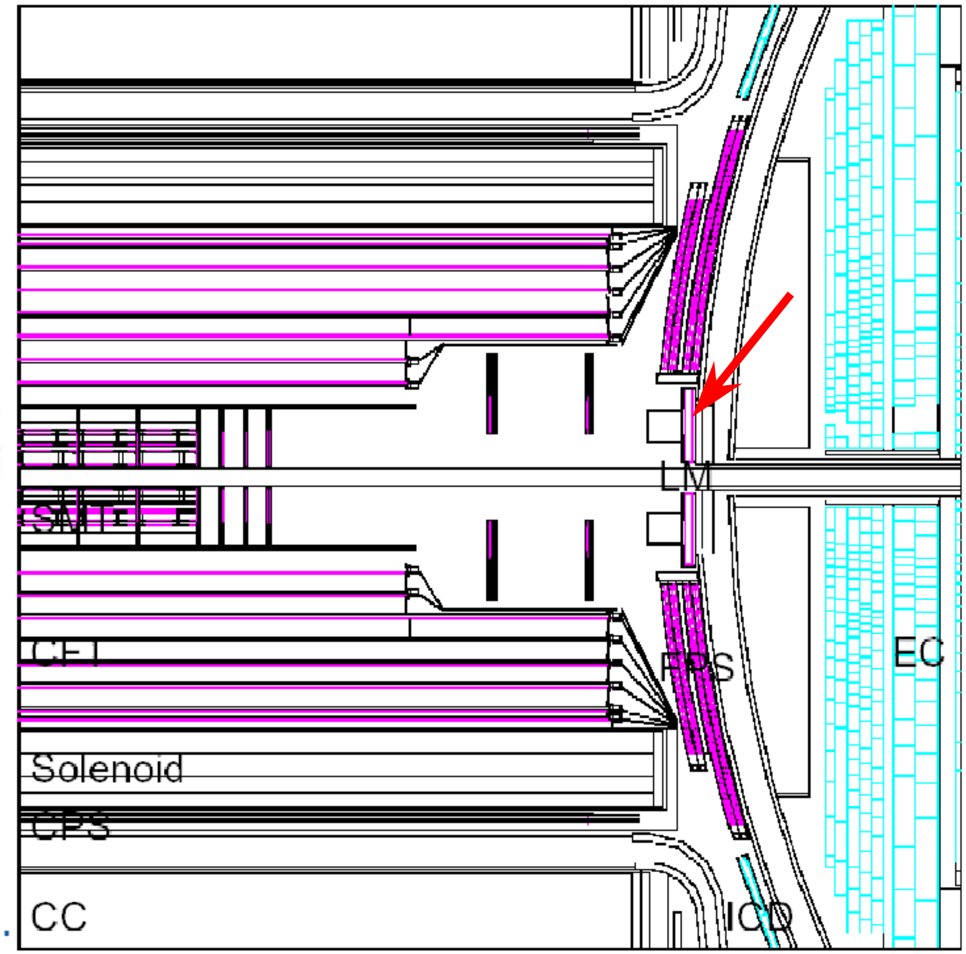
- Manufactured by Toshiba
- Cu:NbTi, He 4.5K cooling
- 2.7 m length
- 2 Tesla, ±4820 Amps
- 5.6 MJoules stored energy
- $0.9X_0$ radiation lengths
- Field uniformity better than 0.5%
- Can discharge in 15 seconds
- No return yoke
- Field monitored by system of Hall probes



Luminosity Monitor

- Plastic scintillators with photomultipliers.
- 24 wedges mounted on each calorimeter end-cap at $z \approx \pm 140$cm.





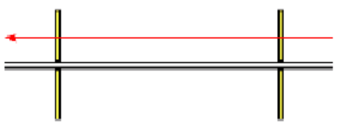
- Coverage is $2.7 < |\eta| < 4.4$.
- Located in $\approx$ 1 Tesla magnetic field.
- Time-of-flight resolution $\approx$ 200 ps.

Harry Weerts

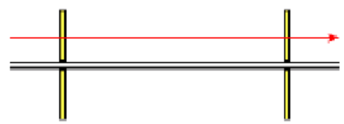
Luminosity Calculations

Coincidences (N^S) are stored in scalers per accelerator tick and Level trigger bit

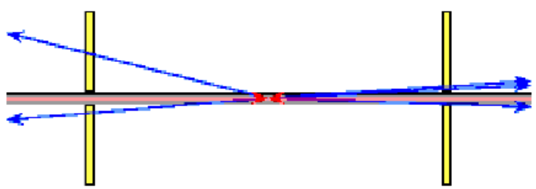
Proton Halo



Anti-Proton Halo



Luminosity
(Collisions)



Counting Zeros

The average number of interactions per beam crossing, μ, is proportional to the luminosity and follows a Poisson distribution. The probability of n interactions in a given crossing is

$$P(n) = \frac{\mu^n}{n!} e^{-\mu}.$$

The probability of at least one interaction (detector signal) is

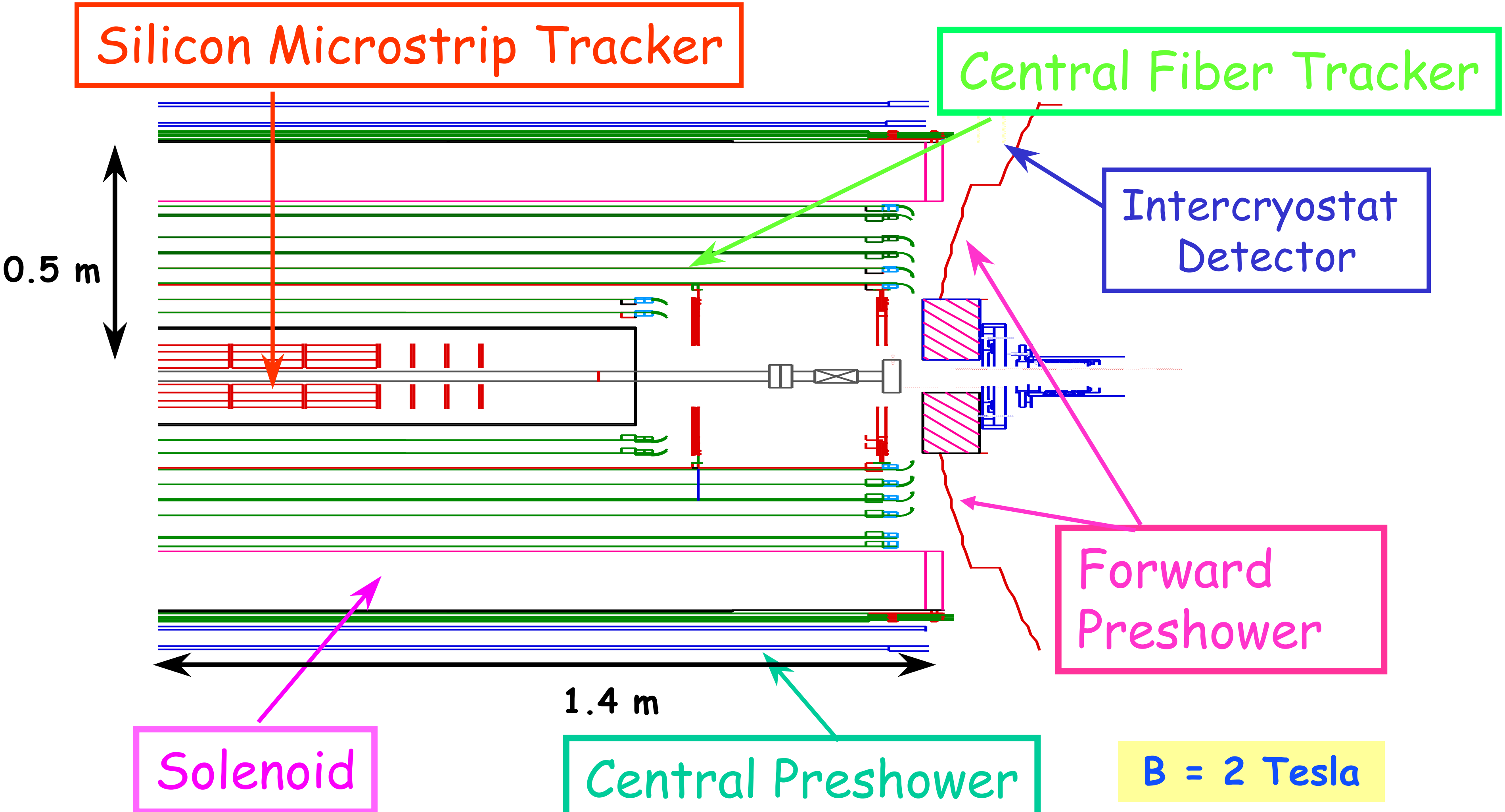
$$P(n > 0) = 1 - e^{-\mu}.$$

Since $\mu = \mathcal{L}\sigma_{\text{eff}}/\text{crossing rate}$,

$$\mathcal{L} = -\frac{\text{crossing rate}}{\sigma_{\text{eff}}} \ln(1 - P(n > 0))$$

σ_{eff}= 43mb (estimate)
Crossing rate= 7.58MHz

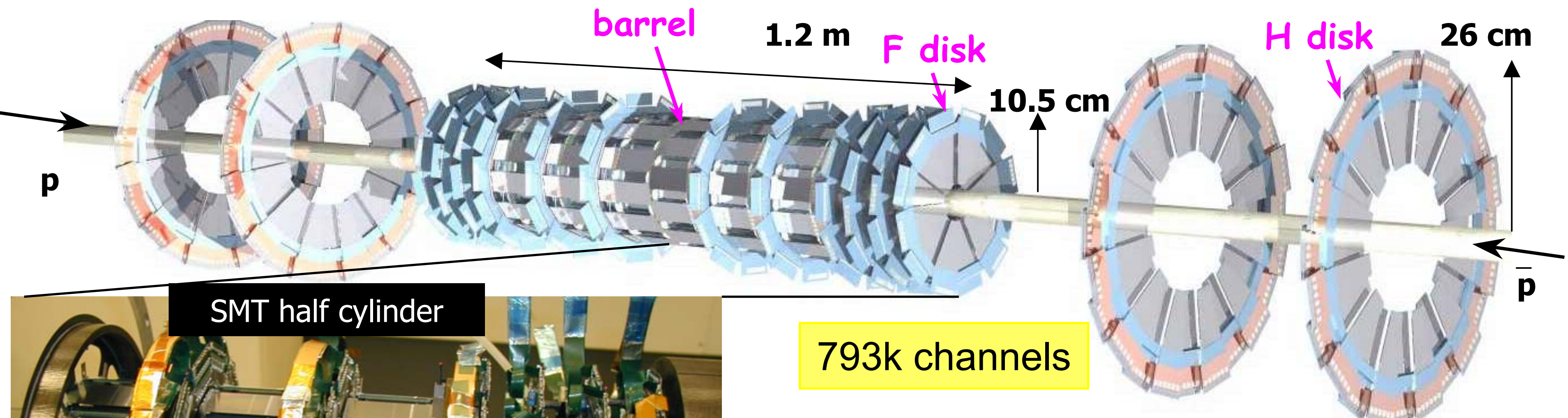
DØ Upgraded Tracking System Overview

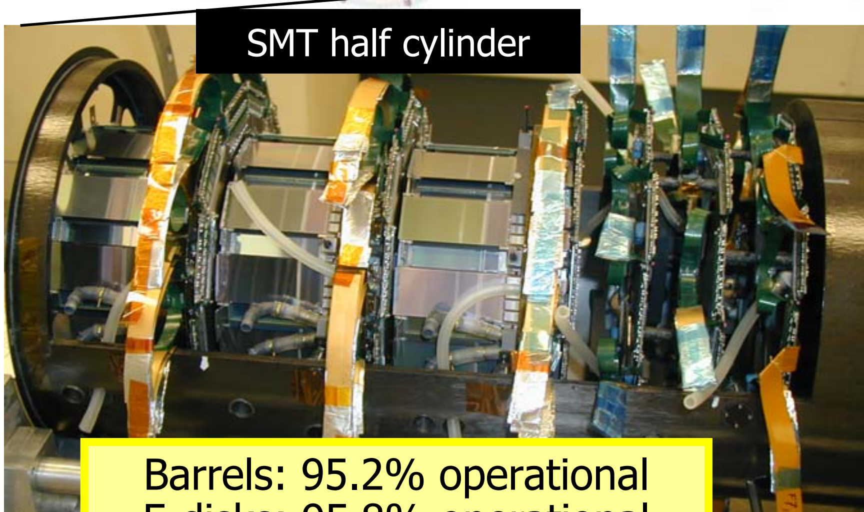


B = 2 Tesla

Charged Particle Momentum Resolution: $\Delta p_T/p_T$ ~ 5% @ p_T = 10 GeV/c

Silicon Microstrip Tracker





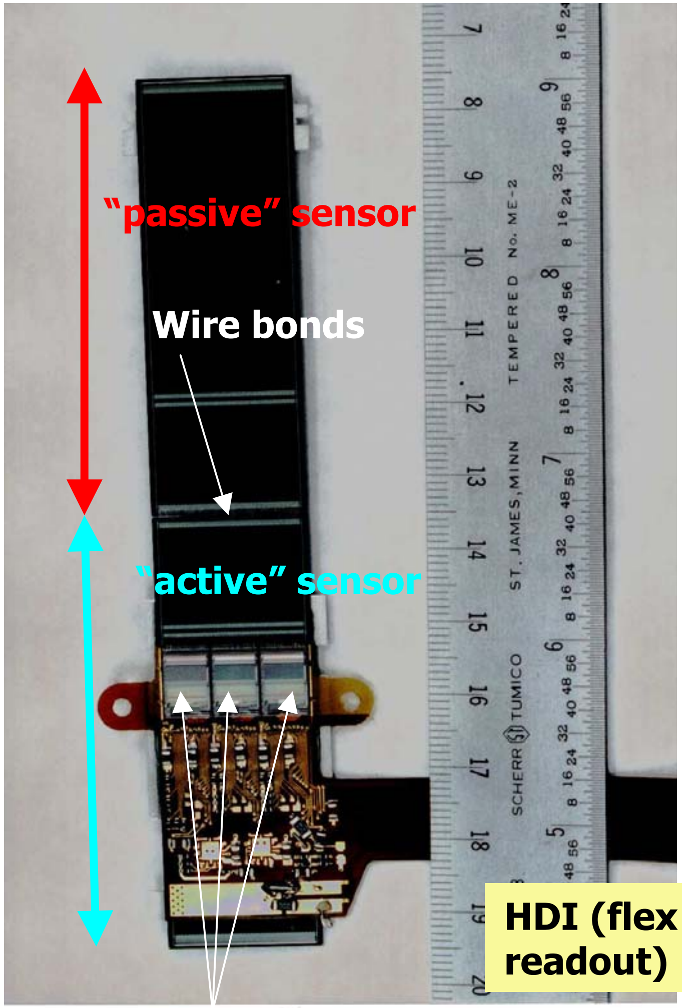
793k channels

Barrels: 95.2% operational
F-disks: 95.8% operational
H-disks: 86.5% operational

- 6 Barrels – 4 layers SS+DS, 432 ladders axial/2^o/90^o stereo
- 12 Central F-disks DS, 144 wedges, $\pm 15^o$ stereo
- 4 Forward H-disks SS, 96 wedges $\pm 7.5^o$ stereo
- Provide tracking out to $|\eta| < 2.5$ with disks
- 3m² silicon, 793k channels multiplexed readout
- Rad hard > 1 Mrad
- 6 detector types
  - 3,6,8,9 chip readout (SVXIIe)

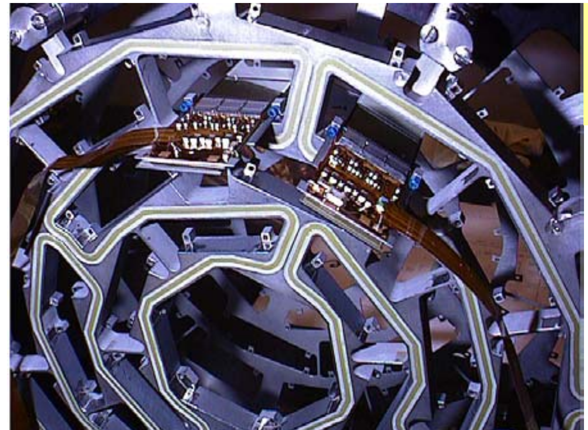
- Tagging efficiency at p_T = 50 GeV/c
  - ~ 60% for b-quark jets,
    ~ 15% for c-quark jets
  - ~ 2% fake tag rate for u,d,s quark jets

Silicon Assembly

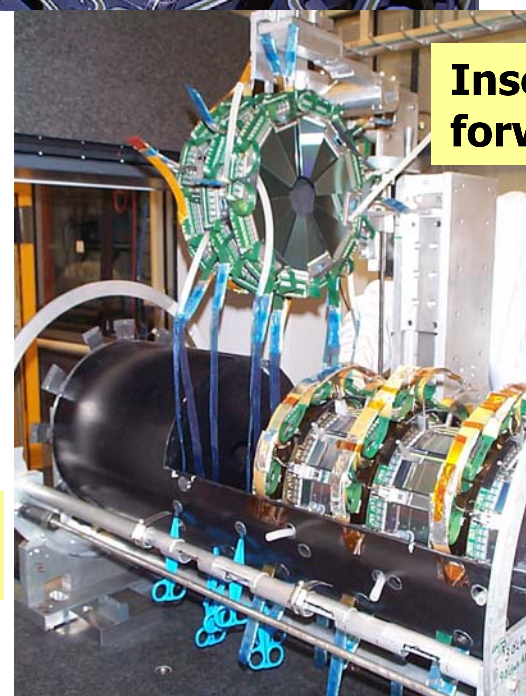


HDI (flex circuit readout)

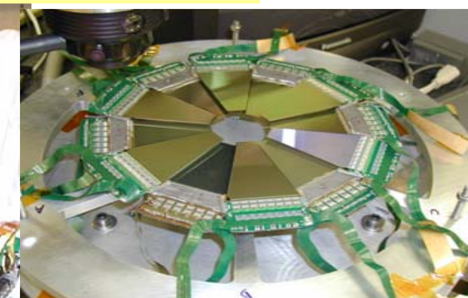
SVX2e readout chips



Beryllium bulkhead

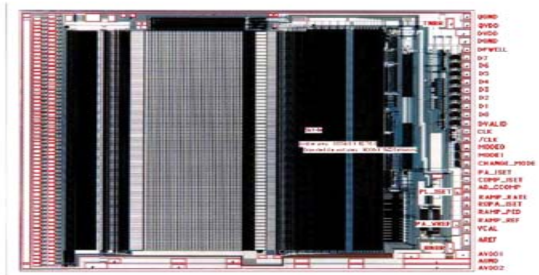


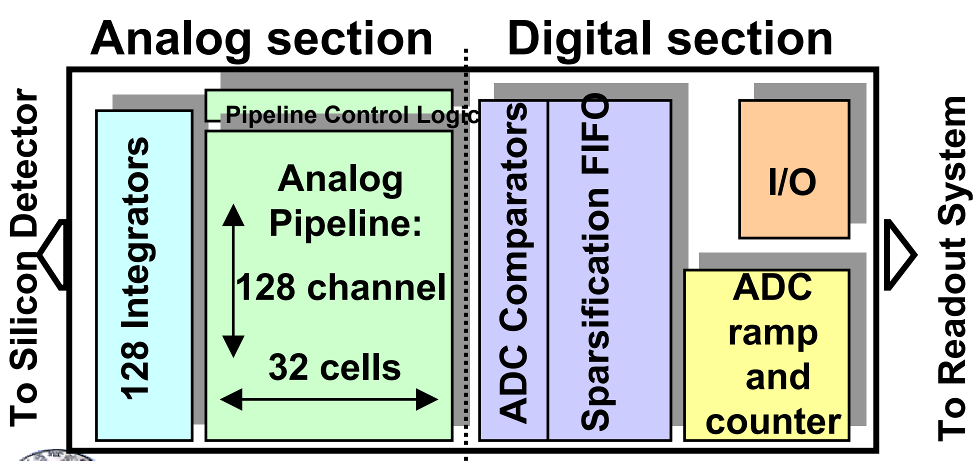
Inserting the forward disks



SMT Readout Electronics

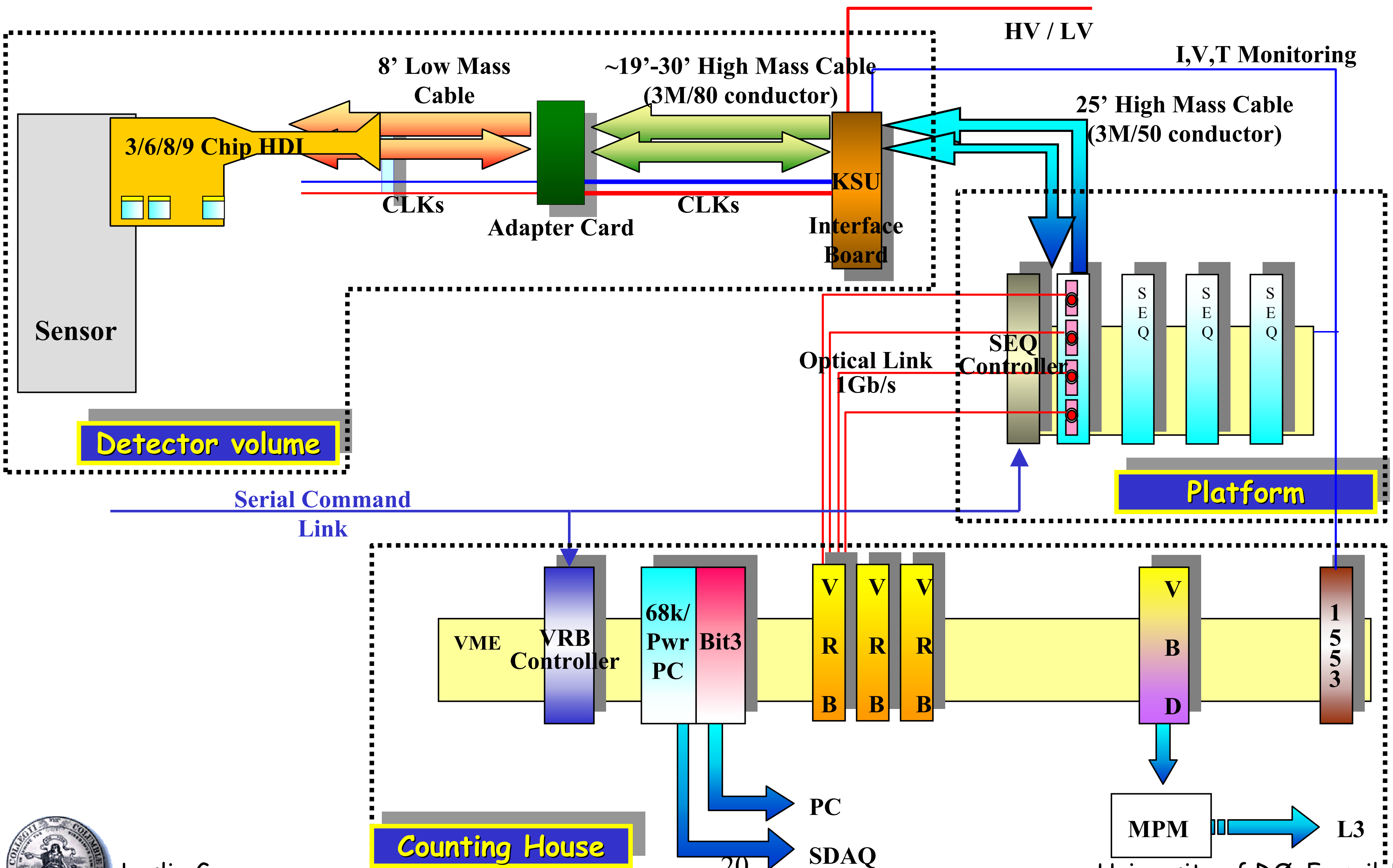
- **SVX IIe Chip**
  - 128 channel, 32 pipeline cells
  - 8 bit ADC with sparsification
  - 106 MHz digitization, 53 MHz readout
  - Radiation hard
  - Developed by LBL/Fermilab group





- **Interface Boards**
  - Refresh signals and adjust timing
  - Power management and monitoring
- **SEQencers**
  - Management of SVX
  - Conversion to fiber optics
- **VRB (VME Readout Buffer)**
  - Data buffer pending L2 trigger decision
  - ~ 50 Mb/s/channel
  - 5-10 kHz L1 accept
  - →1 kHz L2 accept rate

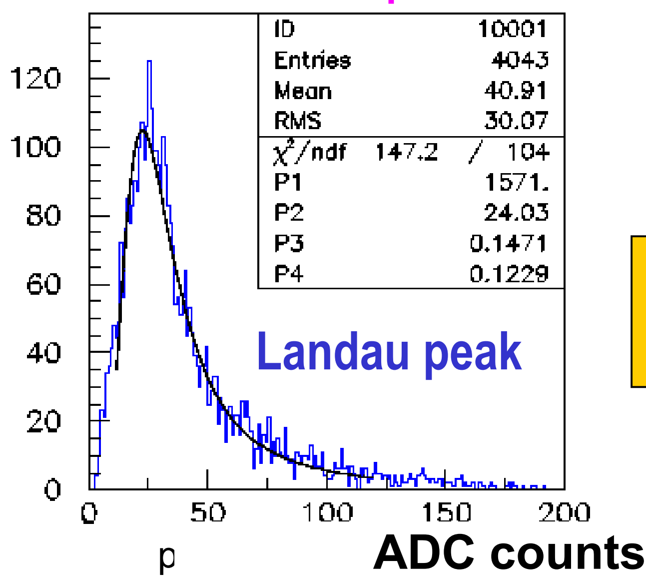
SMT Readout: Data Flow



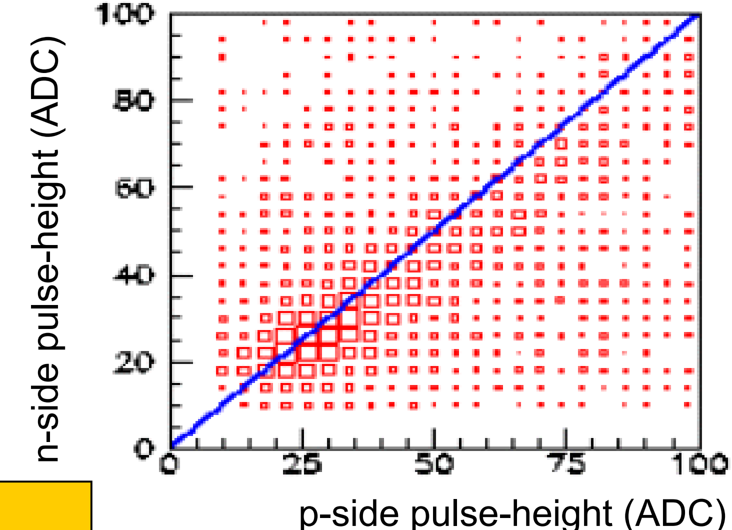
Leslie Groer
Columbia University

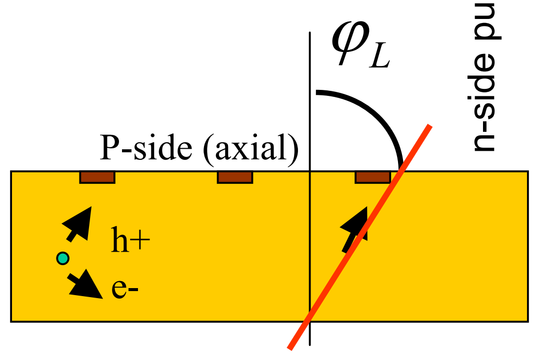
SMT Charge Collection

- **Cluster charge (corrected for track angle):**
  - 1 mip ~ 4fC ~ 25 ADC counts.
  - Noise < 2ADC counts
  - S/N > 10 as expected

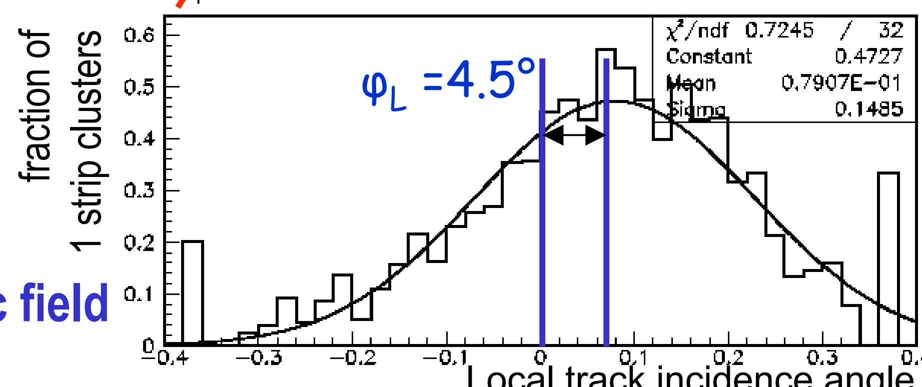


- **Charge correlation between p- and n-side of a detector**





- **Lorentz angle: The charge deflection due to the magnetic field**



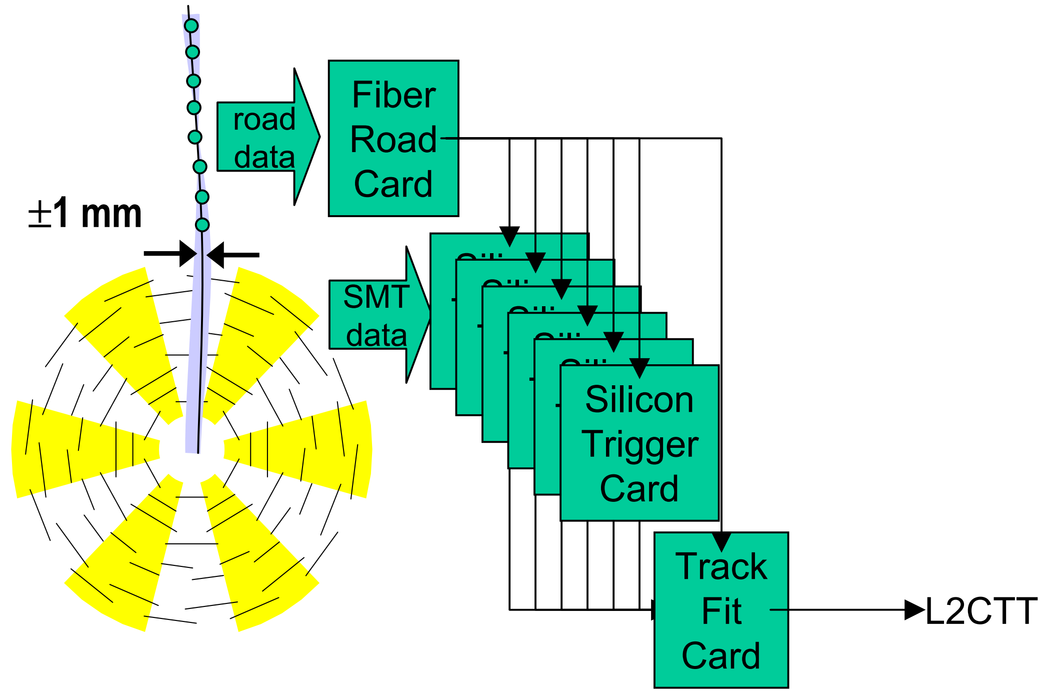
SMT Status

- Had to overcome numerous vendor related problems in design and production for HDIs, Silicon Sensors, jumpers, low mass cables
  - Physicists dragooned into final stages of assembly and testing to make the schedule
- Alignment results show that the DØ SMT was assembled and installed very well.
- The installation in the D0 detector went rather smoothly. The biggest challenge to overcome was the lack of real estate. The D0 detector, when first designed, was unfortunately not designed with a Silicon detector in mind
- The SMT was the first major DØ Upgrade detector system fully operational for Run IIa.
- Some initial disruptions to smooth SMT operations due to difficulty of access
  - Developed resistive fuses
  - Low Voltage Power Supply fuses and burn-out
  - Water leaks from heat exchangers
  - HV trips
- >90% of the channels are functional
- With negative p-side bias on double-sided detectors, micro-discharges have been observed producing large leakage currents and noise above a certain breakdown voltage
- No problems seen from radiation or beam loss incidents
- SMT will be replaced for Run IIb – 6 layers, single-sided sensors only

Great success for DØ!

Silicon Track Trigger

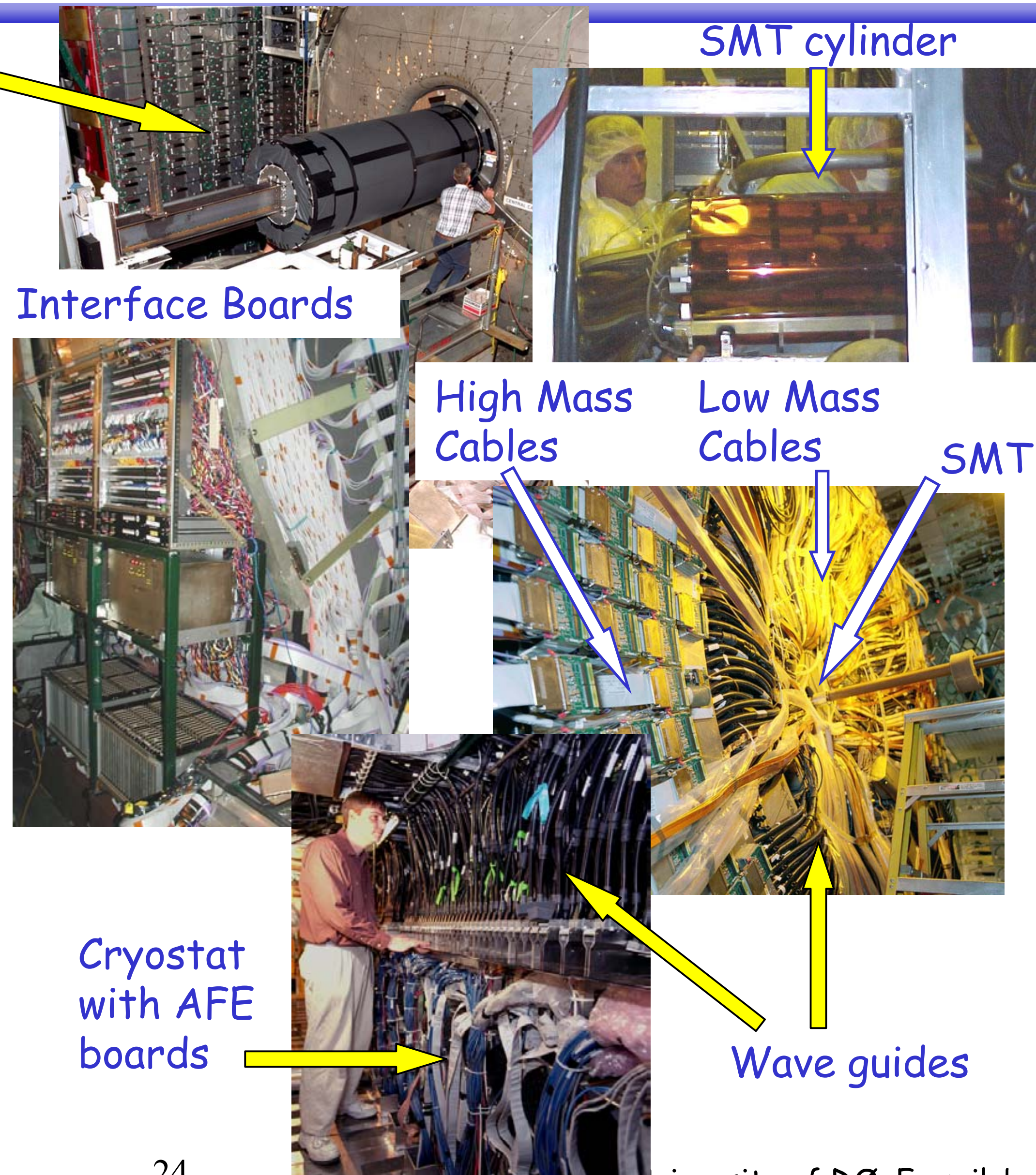
- L1CTT finds tracks in CFT
- Fiber Road Card
  - Receives tracks from L1CTT and trigger info
  - transmits trigger road info to STC+TFC
- Silicon Trigger Card
  - Select SMT clusters in roads
  - Receives raw data from SMT
  - Finds clusters in axial and stereo strips
  - Associates tracks with axial clusters
- Track Fit Card
  - Take FRC roads and STC clusters and fit track trajectory
  - Output Track list to L2



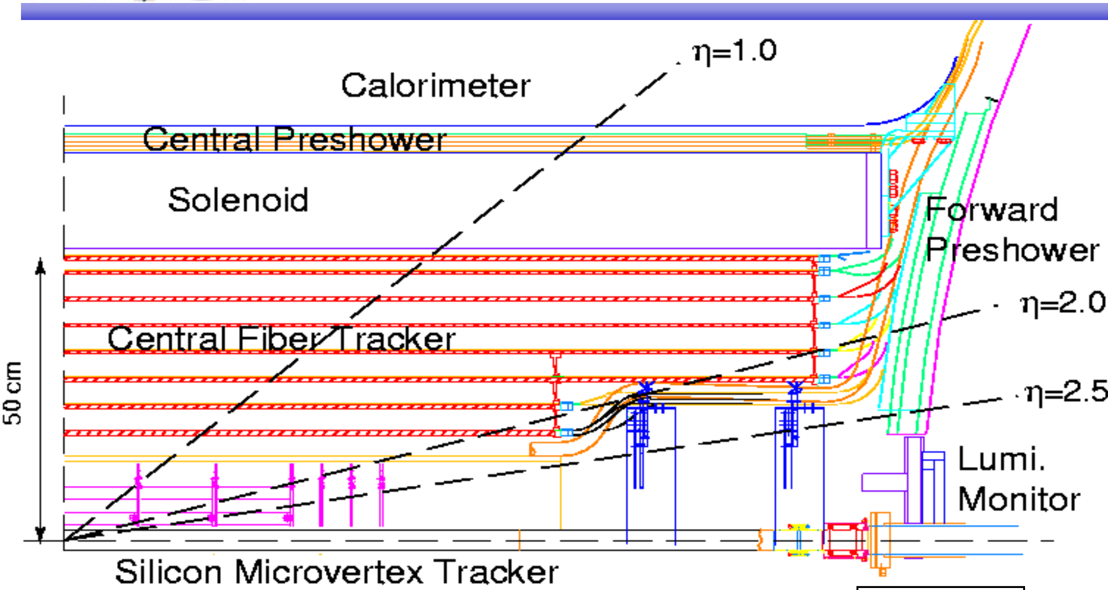
Online this summer!

Installation of Trackers

- Fiber tracker installation
- SMT Cylinder installation was completed on 12/20/00
  - A ½ cylinder of 3 barrels and 6 F disks was inserted into each end of the CFT bore
- H Disk installation was completed on 2/6/01
- The cabling (~15,000 connections) and electronics installation was completed in May 2001
- Axial Fiber Tracker electronics installed in November 2001
- Stereo electronics completed April 2002

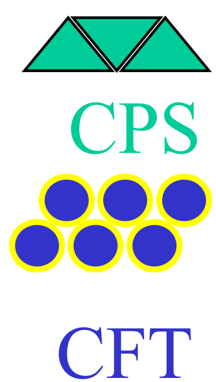


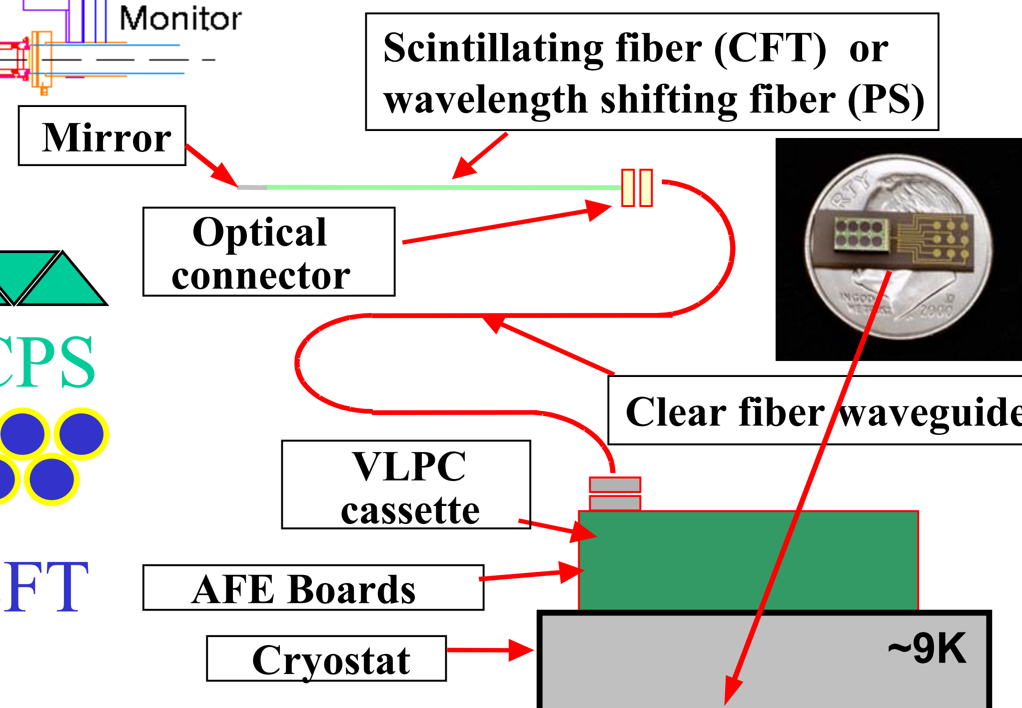
Overview of VLPC Detectors



76,800 channels in the CFT readout
7,680 channels in the CPS readout
14,884 channels in the FPS readout

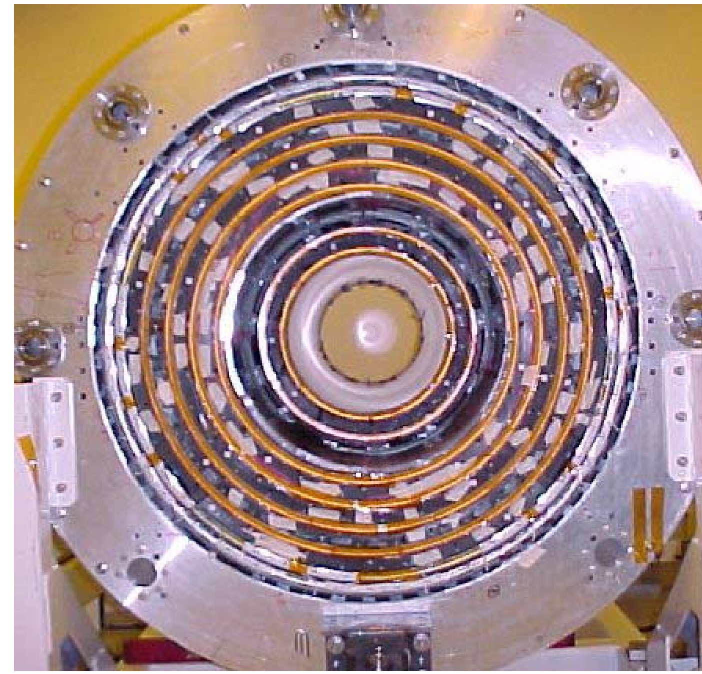
- **The 3 VLPC detectors use Analog Front End (AFE) boards for trigger and readout**



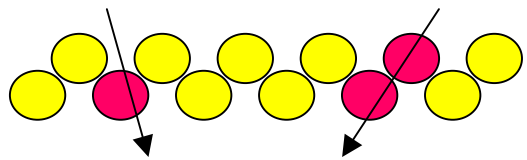


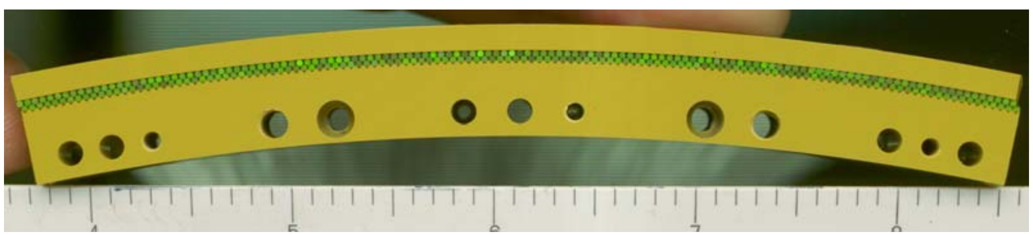
CFT Design

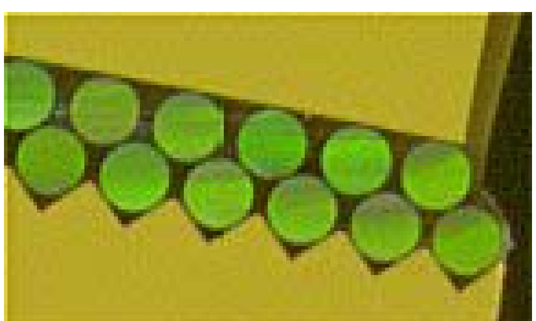
- 8 double layers of axial and 3° stereo fibers mounted on carbon fiber support cylinders
- 20cm < r < 51cm
- Tracking out to eta < 1.7



$$\frac{\sigma_{p_T}}{p_T} = 0.015 \oplus 0.0014 p_T$$



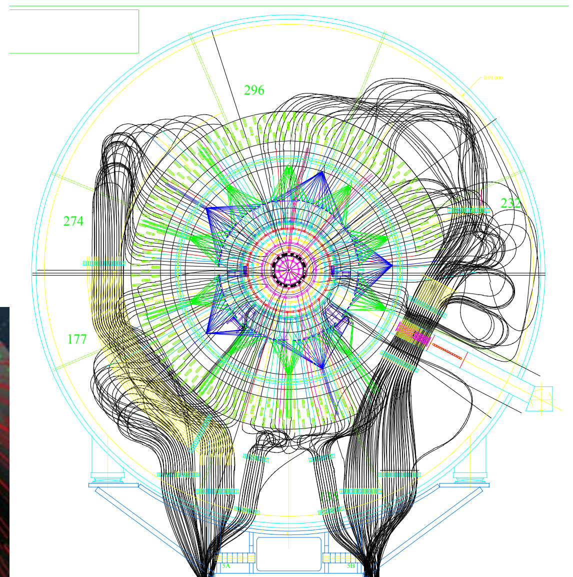


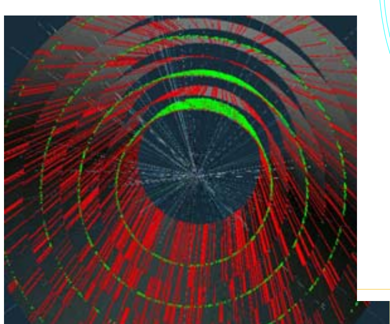


- 76,800 individual fibers
- Diameter: 835μm. Length: 1.8 or 2.6m
- The interlocked fibers are precisely positioned
- Hit resolution about 100μm
- Trackers shifted in z by 2.9 cm w.r.t. calorimeter → shifts z_0

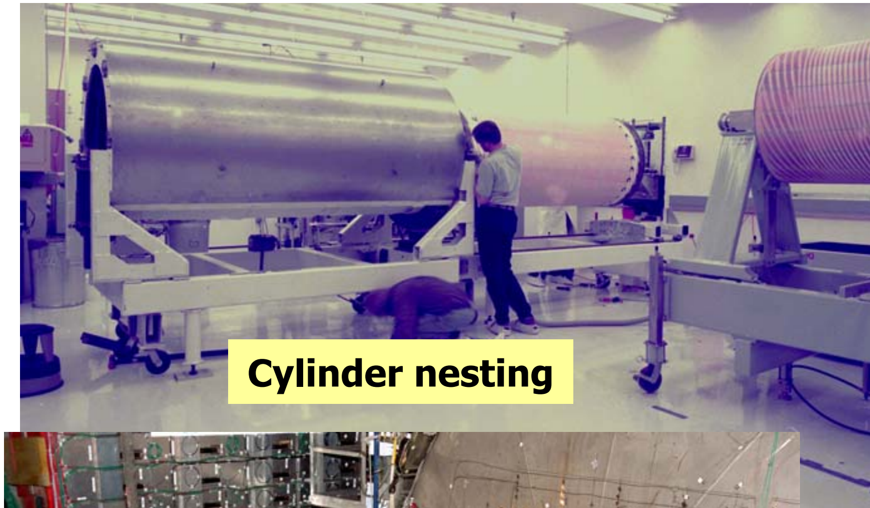
DØ Scintillating Fiber Tracker Assembly

Tracker cabling on the face of calorimeters





Tracker geometry and simulation of particle tracks



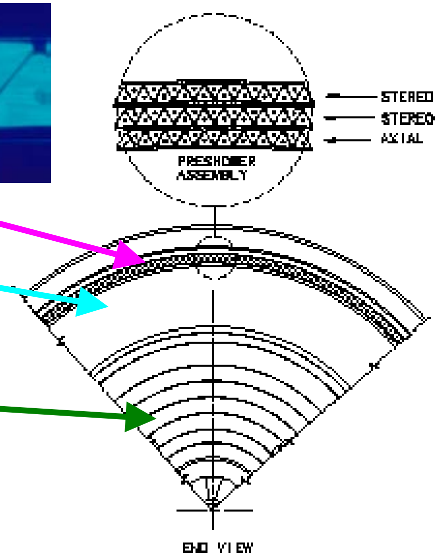
Cylinder nesting

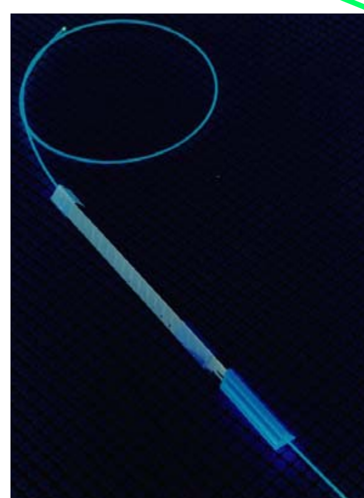
Ribbon manufacture

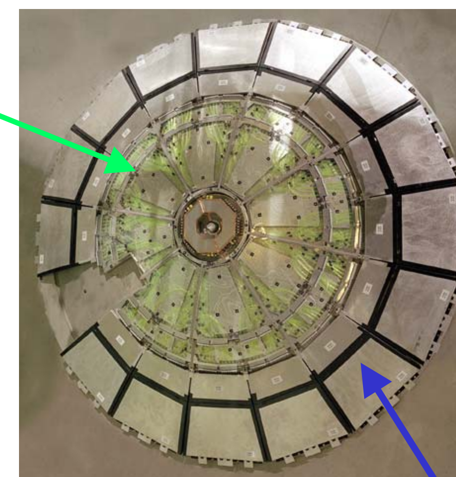
Tracker Installation

Central and Forward Preshowers

- **Central and Forward Preshowers**
  - Central mounted on solenoid ($|\eta| < 1.2$)
  - Forward on calorimeter endcaps ($1.4 < |\eta| < 2.5$)
  - CPS: 7,680 FPS: 14,000 channels
  - Extruded triangular scintillator strips with embedded WLS fibers and Pb absorber
  - Improve energy resolution measurements
  - Trigger on low-p_T EM showers

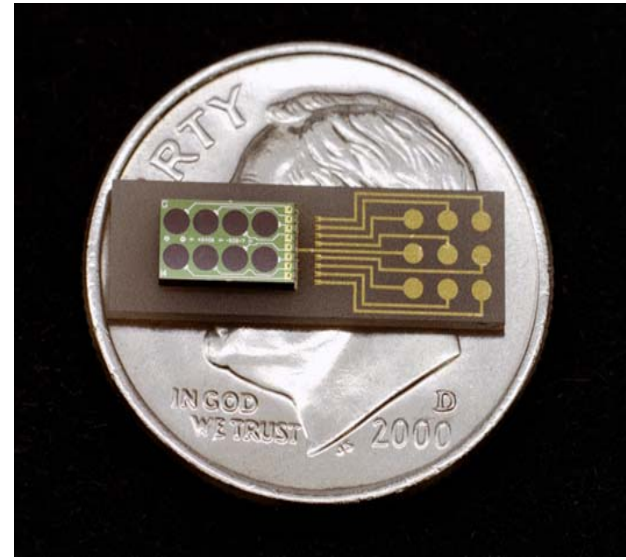




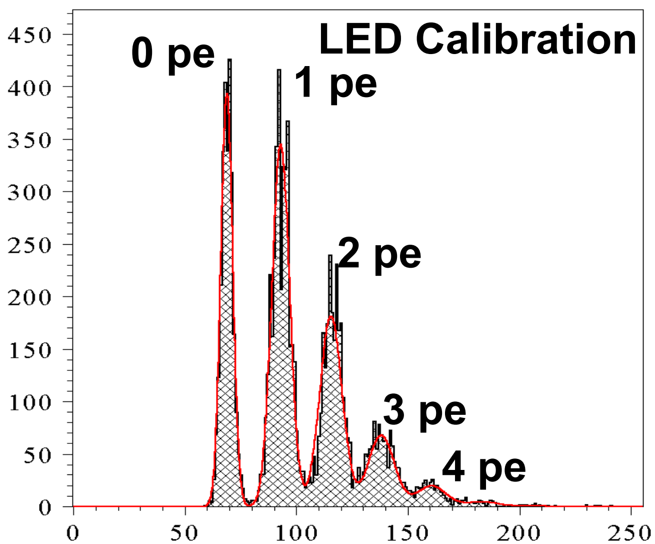


VLPC Readout Electronics

- **~8-12m long wave-guides to Visible Light Photon Counter (VLPC)**
  - Solid state photo multiplier, 8 per chip)
  - Operated at 9K
  - Quantum efficiency: 80%
  - High gain: 17k – 65k e per photon

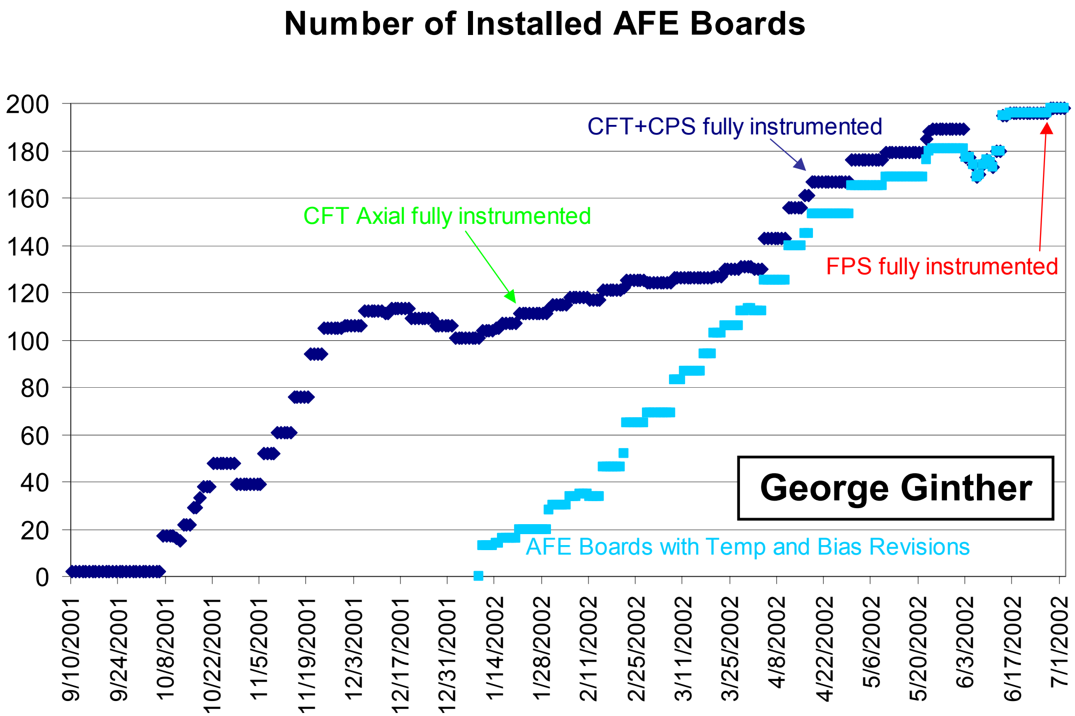


1 pe ~ 7 fC ~ 15 ADC counts
Expected signal for MIP ~ 8 pe in CFT
Excellent signal/noise performance



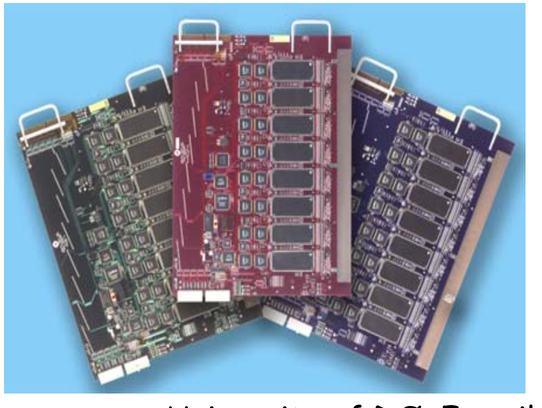
- **AFE boards provide**
  - Bias voltage + Temperature control for VLPC
  - Fast discriminator digital trigger information for L1CTT
  - Analog pulse information (SVXII chip)
  - 512 channels per board
    - 8 MCM each with 4 SVX + 1 SIFT chip
- **SEQ + VRB readout as SMT**

AFE Board Installation



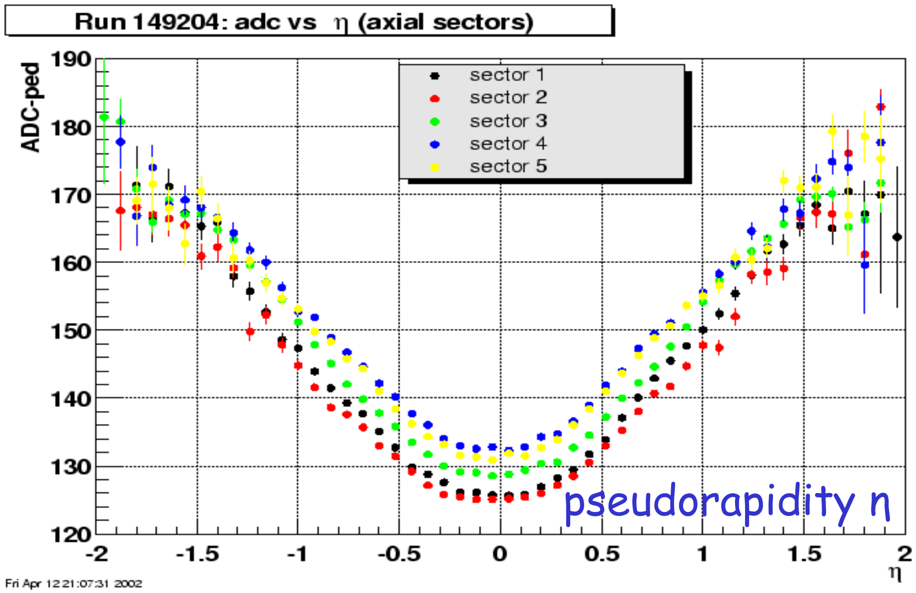
- CFT+CPS fully instrumented by mid-April 2002
- FPS fully instrumented end June 2002
- Readout system is generally stable and well behaved
- Substantial progress developing, testing, and integrating components of the L1 Central Track Trigger

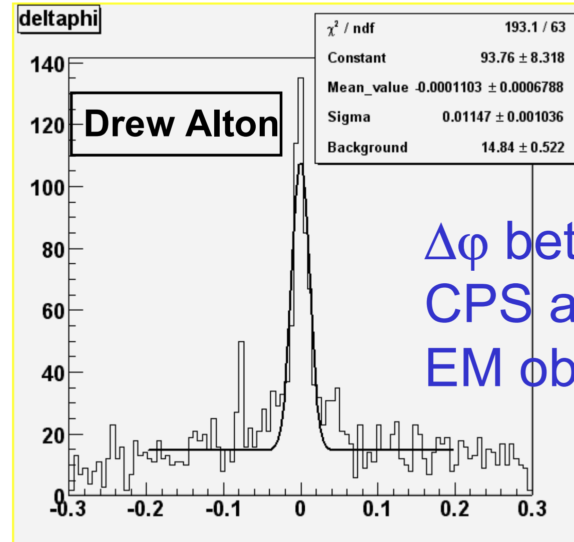
- Initial commissioning of CFT+PS (and waveguide testing) performed using prototype boards
- Installation and commissioning of AFE boards began during the October 2001 shutdown



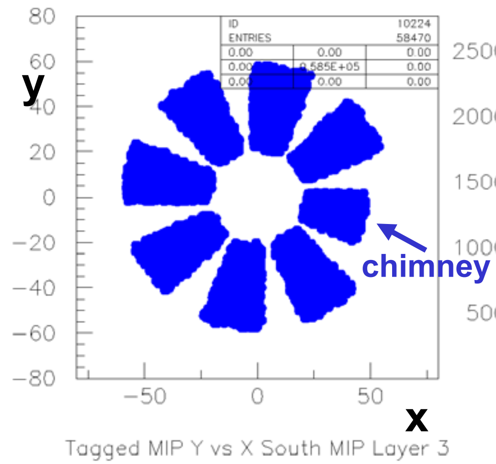
CFT + PS Status

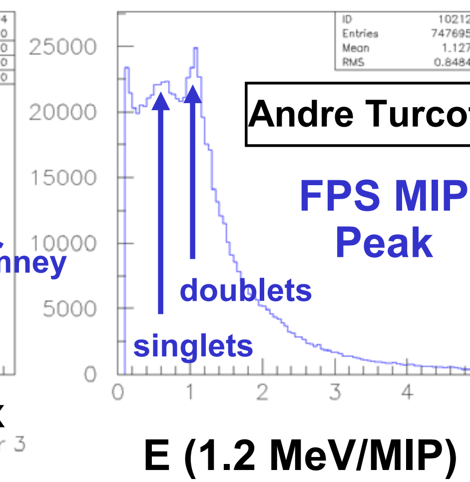
Light yield per sector





Δφ between CPS and EM objects



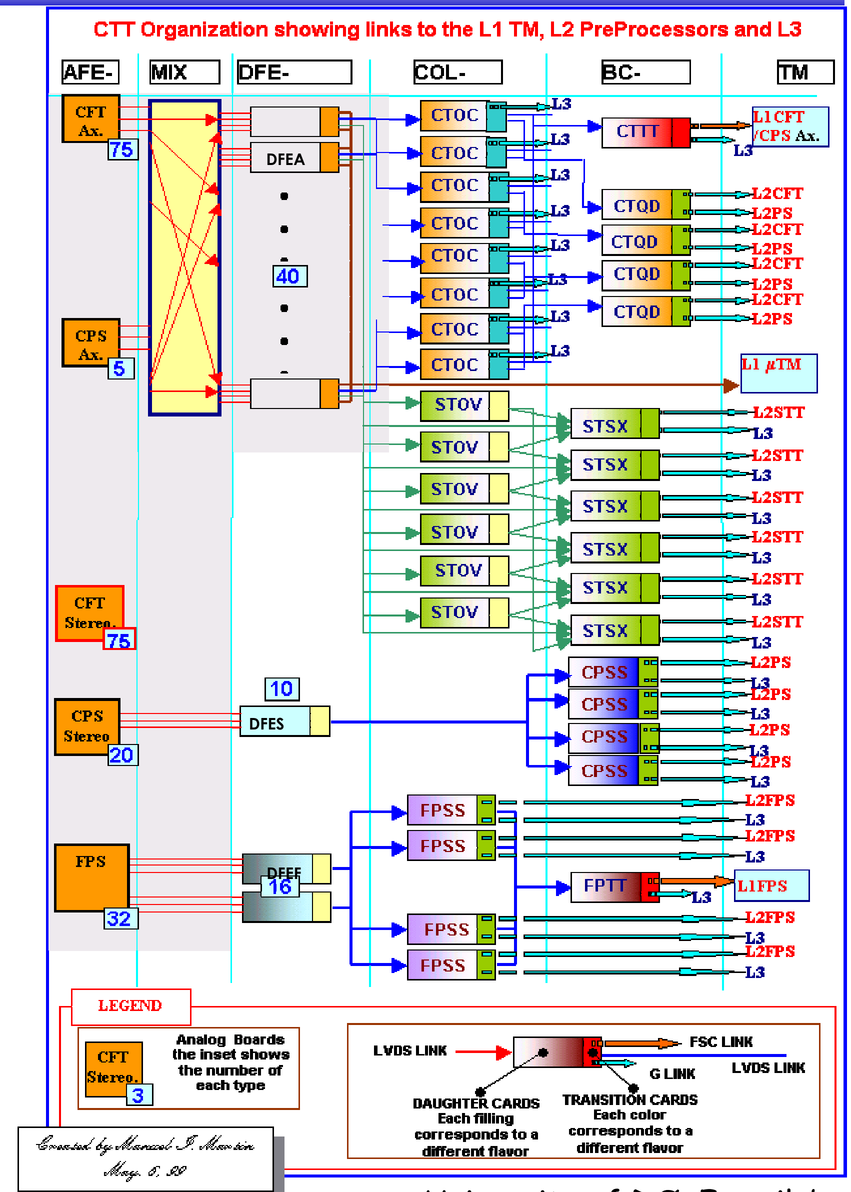


E (1.2 MeV/MIP)

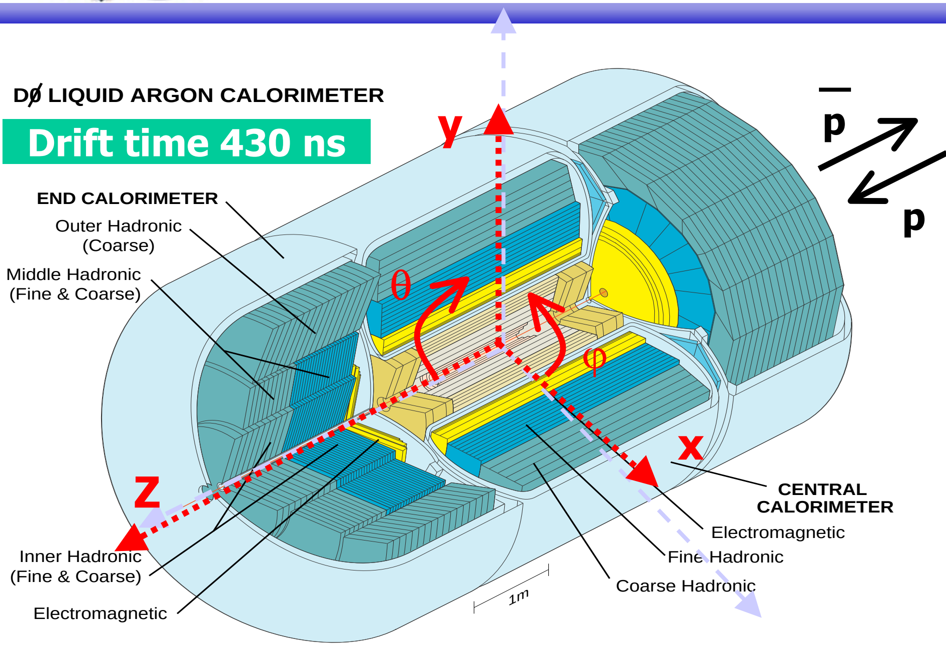
- Detectors performing well
  - CFT hits detected on tracks with > 98% efficiency
- Tuning pedestal thresholds and gains
- Information to be added to calorimetery

Central Track Trigger

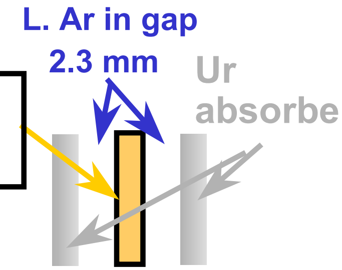
- All hardware is installed and cabled
- Needed to add extra bunch-xing capability to the system to allow the CTT signal to get to L1Muon in time for a trigger decision
- Tracking triggers are running online
- Still working on full coverage and capabilities
- Send information to STT



Liquid Argon Calorimeter

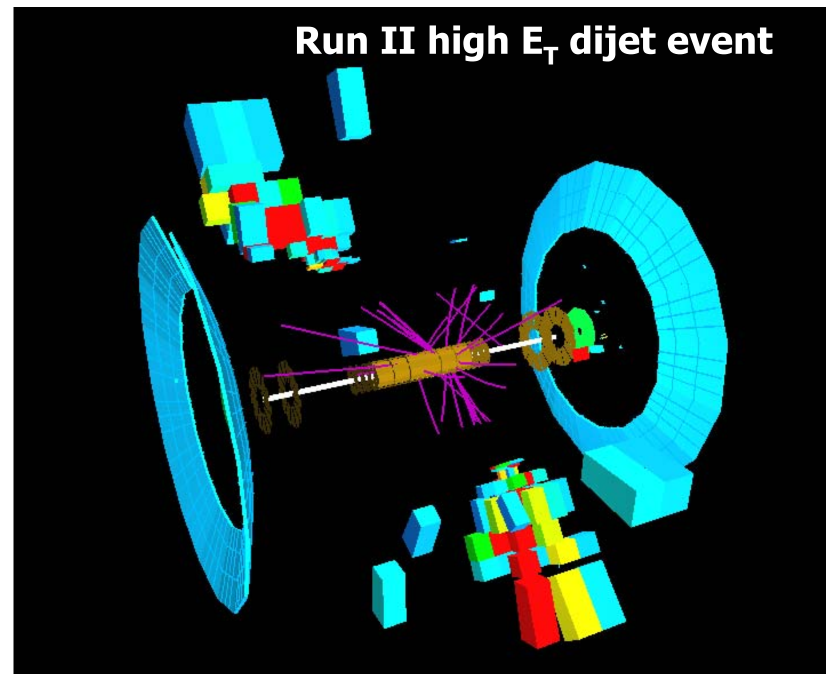


Cu pad readout on 0.5 mm G10 with resistive coat epoxy



Run I Test beam energy resolutions

Electrons:	σ_E / E = 15% / $\sqrt{E\,(\text{GeV})} \oplus$ 0.3%
Pions:	σ_E / E ~ 45% / $\sqrt{E\,(\text{GeV})} \oplus$ 4%

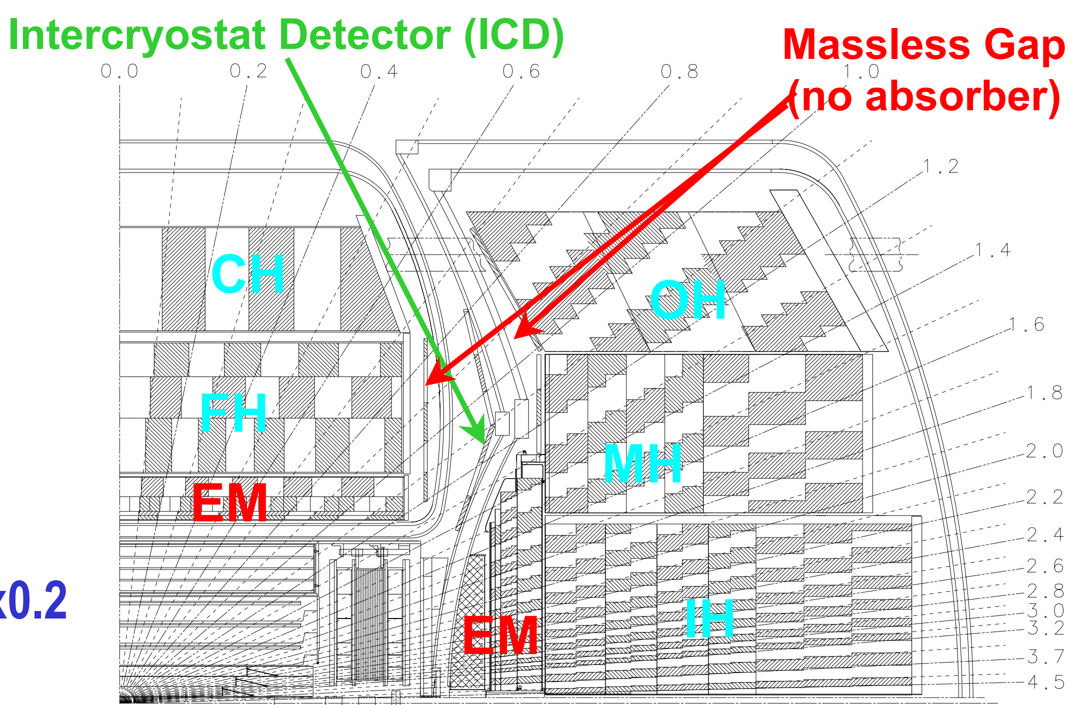


- Liquid argon sampling
  - Stable, uniform response, rad. hard
  - LAr purity important (< 0.7 ppm O_2 equivalent)
- Uranium absorber (Cu/Fe for coarse hadronic)
  - dense absorber hence can be compact
  - Nearly compensated EM and hadronic response
  - Linear response
- Hermetic with full coverage
  - $|\eta| < 4.2$ ($\theta \approx 2^o$)
  - $\lambda_{int} > 7.2$ (total)

Calorimeter Segmentation

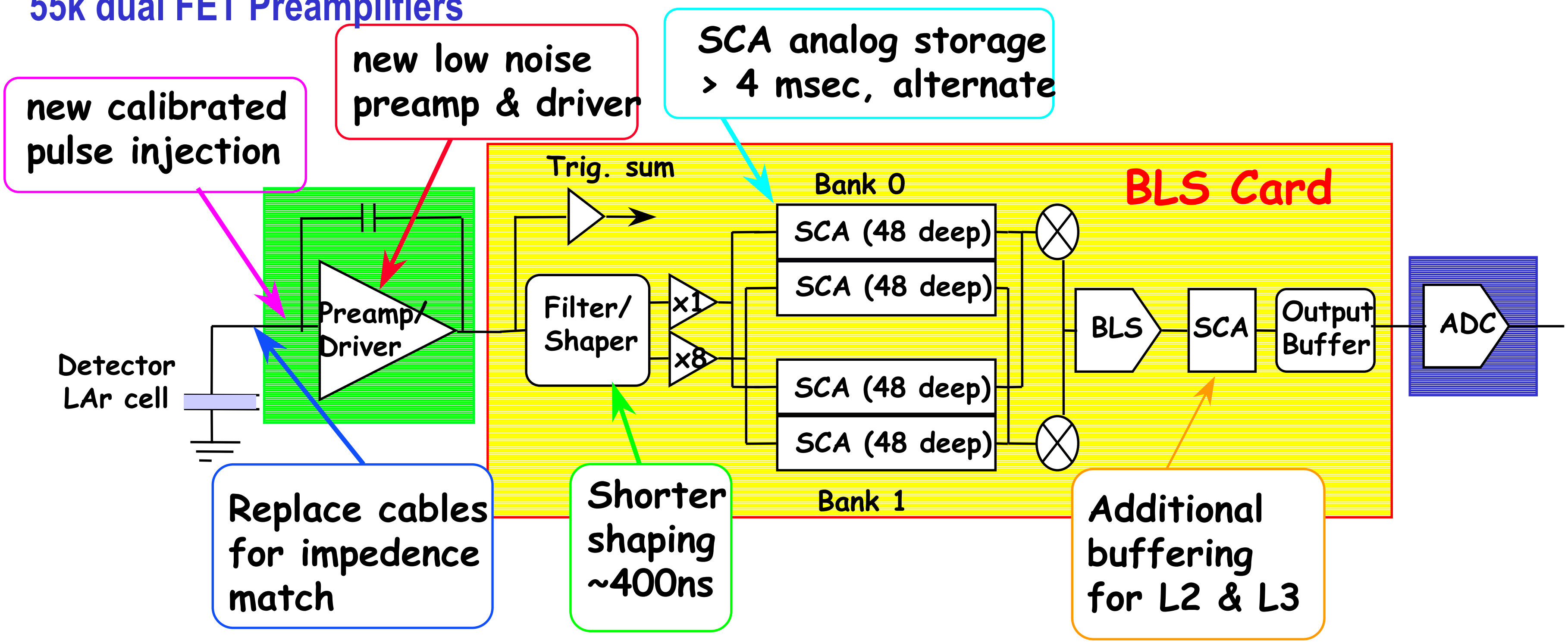
- 50k readout cells (<0.1% bad)
- Arranged in semi-projective towers
- Readout cells ganged in layers
- Readout segmented into η, ϕ for charge detection
  - Transverse segmentation $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$
  - At shower max. (EM3) $\Delta\eta \times \Delta\phi = 0.05 \times 0.05$
- 5k semi-projective towers
  - 4 EM, 4-5 Hadronic (fine and coarse) layers
- Field +2.5 kV (E = 11 kV/cm)
  - drift time ~ 450 ns
- L1/L2 fast Trigger readout 0.2x0.2 towers

Layer	CC	EC
EM1,2,3,4	X_0 : 2,2,7,10 3mm Ur	X_0 : (0.3),3,8,9 (1.4mm Fe) 4mm Ur
FH1,2,3,(4)	λ_0 : 1.3,1.0,0.9 6mm Ur	λ_0 : 1.3,1.2,1.2,1.2 6mm Ur
CH1,(2,3)	λ_0 : 3.0 46.5mm Cu	λ_0 : 3.0, (3.0, 3.0) 46.5mm Fe



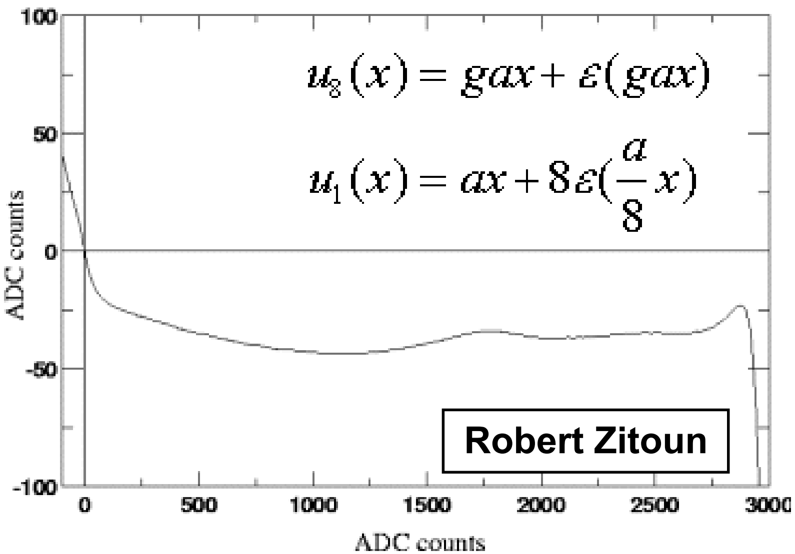
Run 2 Calorimeter Electronics

55k dual FET Preamplifiers



- Design for
  - 400 ns shaping and luminosity of $2x10^{32}$ cm^{-2} s^{-1}
  - Electronics and pile-up noise increase, Uranium noise decreases → comparable to Run 1
- 23k Switched Capacitor Arrays on 1152 BaseLine Subtractor boards
  - Shaping, baseline subtraction and gain selection
- < 0.1% bad electronic channels
- Liquid Argon very pure: < 0.7 ppm of O_2 equivalent; monitored

Calorimeter Calibration



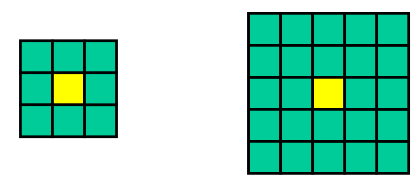
- Non-linearity < 0.3% for E > 2 GeV
- In lower energy domain the effect is significant but can be parameterized
  - 3 correction parameters per readout cell
- Z mass measured at DØ changes from 82.80 GeV to 88.00 GeV after the non-linearity correction

- Timing of signal measurement within 10 ns
- Ongoing effort to understand the electronics and signal gain calibration using pulser and utilize these in reconstruction
- Tuning of zero-suppression thresholds proven to be non-trivial
  - Noise not modeled well initially
  - Algorithms sensitive to noise
- Number of minor board modifications to remove noise pickup in trigger

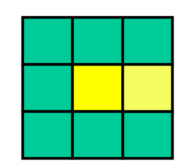
Calorimeter Trigger Objects

- L1 Trigger
  - 0.2x0.2 trigger towers in EM and TOTAL, coverage to |eta| < 3.2
  - Separate readout path and Flash ADC (8-bit)
  - Run II CTFE receiver cards with adjustable gain
  - Trigger on number of towers above a threshold
    - Soon MET and Large Tiles as well
  - L1 information sent to L2
- L2 Trigger
  - Start with list of seed towers from L1
  - Form ET clusters of 3x3 or 5x5 towers above threshold for Jets or largest nearest neighbor towers for EM
  - Order candidates by pT
- L3 Trigger
  - Uses precision readout (15-bit dynamic range)
  - Run cell clustering and form reco EM and Jet objects

L2 Jets

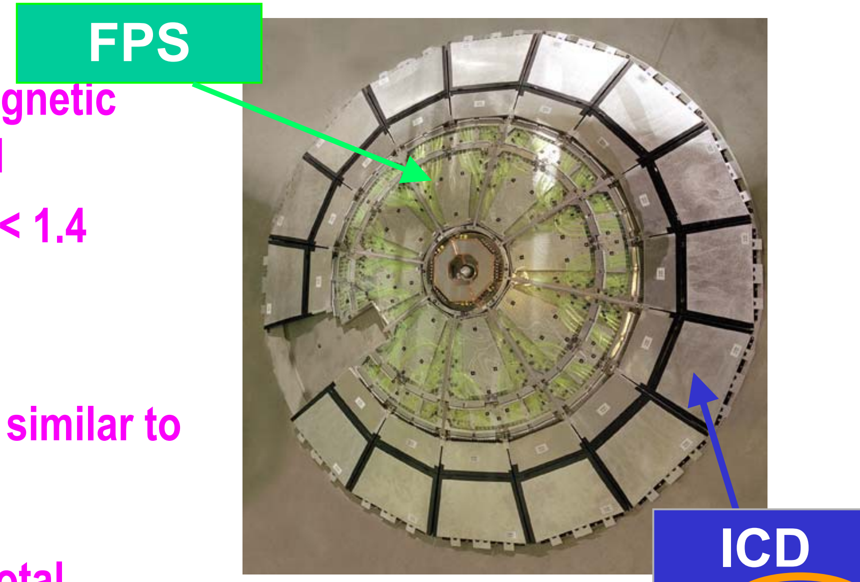


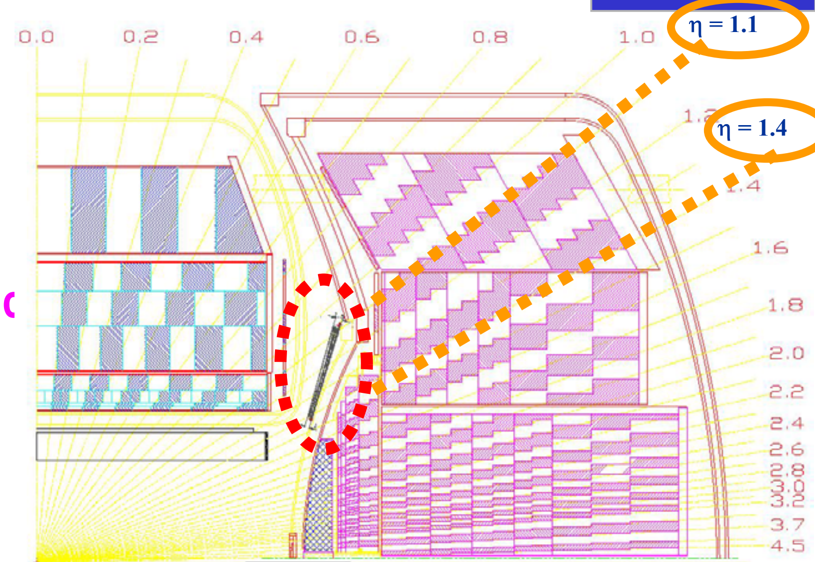
L2 EM



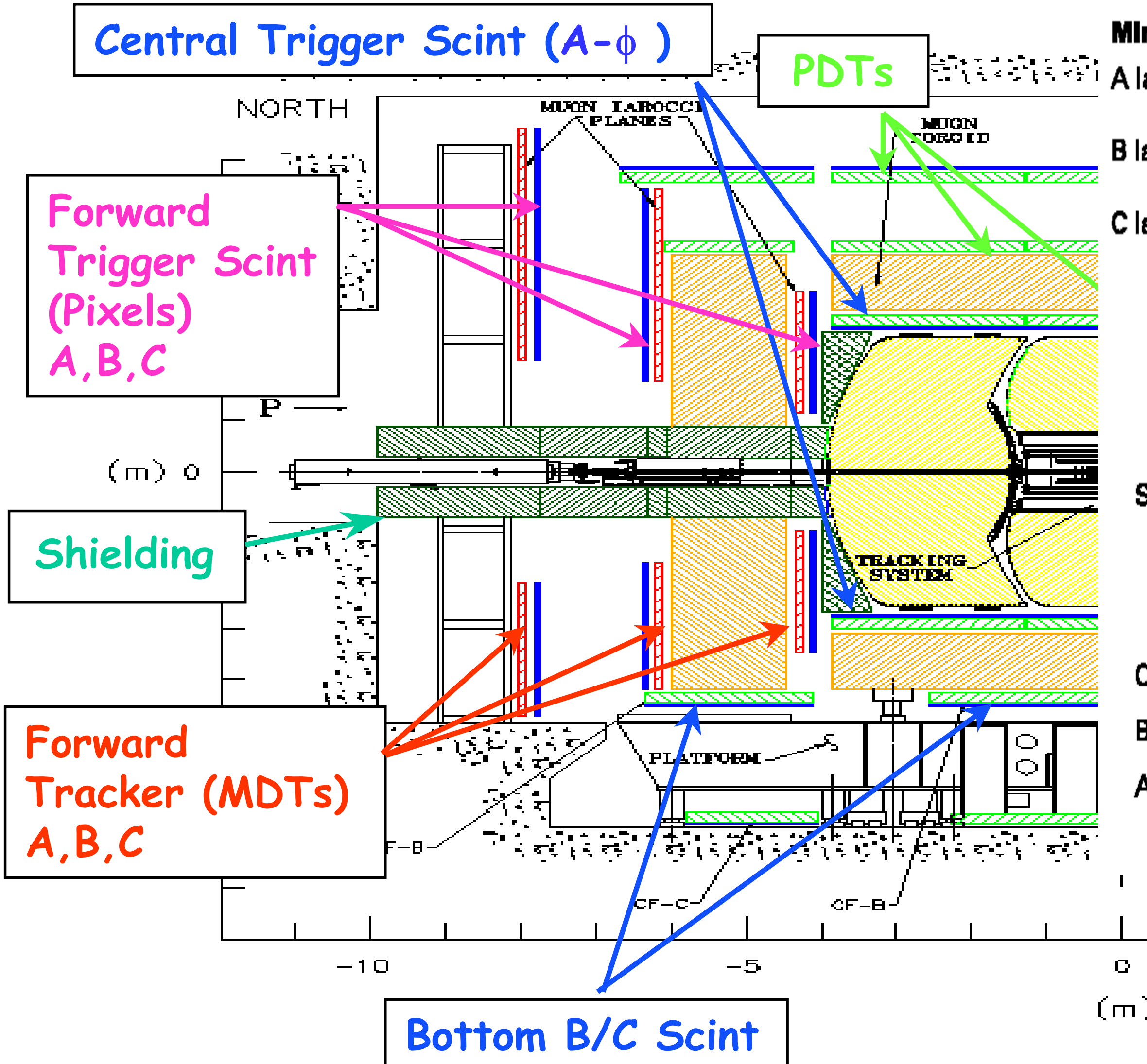
Intercryostat Detector (ICD)

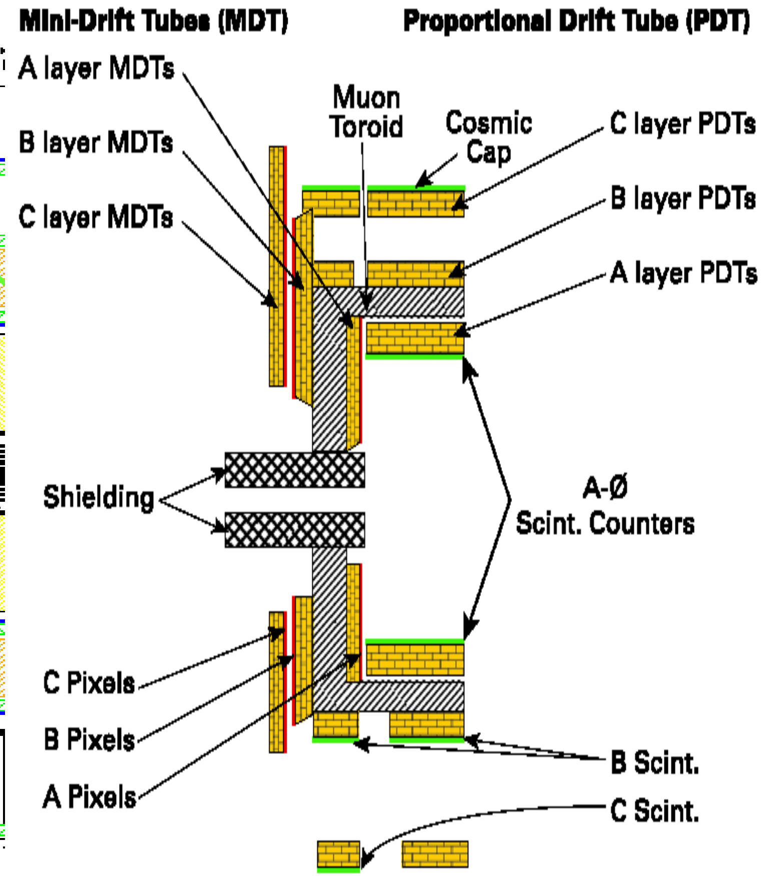
- **Objectives**
  - Maintain performance in presence of a magnetic field and additional material from solenoid
  - Improve coverage for the region $1.1 < |\eta| < 1.4$
  - Improves jet E_T and $\not{E}_T$
- **Design**
  - Scintillator based with phototube readout similar to Run I design. Re-use existing PMT's (Hamamatsu R647)
  - 16 *supertile* modules per cryostat with a total of 384 scintillator tiles
  - WLS fiber readout of scintillator tiles
  - Clear fiber light piping to region of low field ~40-50% signal loss over 5-6m fiber.
  - Readout and calibration scheme for electronic same as for L. Ar. Calorimeter but with adapted electronics and pulser shapes
  - LED pulsers used for PMT calibration
  - Relative yields measured > 20 p.e./m.i.p.





Muon Detector Upgrade



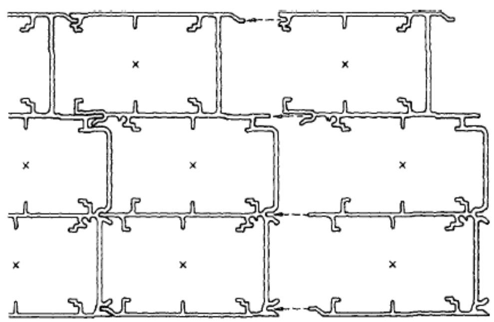


- Muon rapidity coverage to eta of 2.0
- Shielding reduces backgrounds by 50-100x

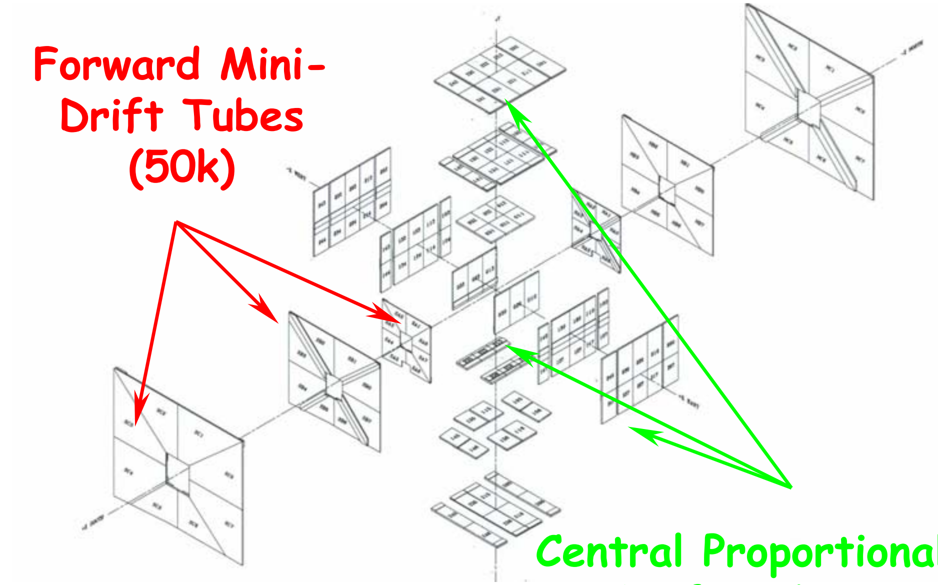
Muon Tracking Systems

Systems of Drift Tubes

- Proportional Drift Tubes (PDT's) – Central (from Run I)
  - 6624 drift cells (10.1 cm x 5.5 cm) in 94 three- and four-deck chambers



- Forward Tracking (MDT's)
  - 6080 eight-cell tubes in 8 octants per layer, cross-section 9.4 mm x 9.4 mm x 0.7 mm
  - 50k 50 mm gold plated tungsten wire 3.25kV

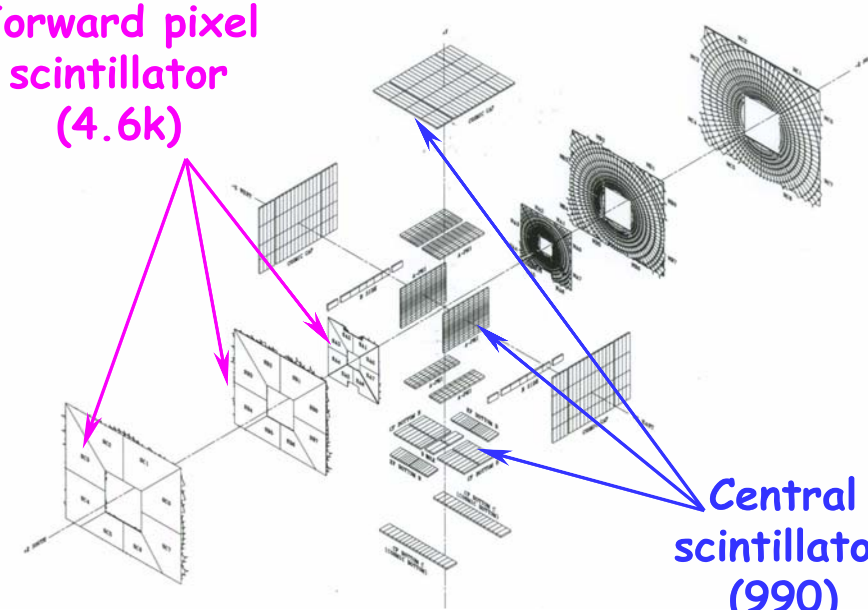


- Rad. hard, fast gas CF_4(90%)+CH_4(10%)
- 4+3+3 hits for each muon track
- Drift times about 100 ns PDT, 50 ns MDT
- Position resolutions ~ 0.5-0.7 mm
- HV calibrated < 0.25%,< 0.5% dead channels
- Hit efficiencies > 98-99%
- Standalone $\delta p/p$ ~ 20%

Muon Trigger Systems

Triggers based on fast scintillator

- Central Scintillation Counters
  - 360 "cosmic cap" counters outside the toroid ($\Delta\varphi$=22.5^o)
  - 630 "A-φ" counters inside ($\Delta\varphi$=4.5^o), $\Delta\eta$=0.1
- Forward scintillation counters (pixels)
  - 4608 counters on the north and south side of the detector
  - $\Delta\varphi$=4.5^o matches the MDT sector size. $\Delta\eta$=0.12 except the last three rows where $\Delta\eta$=0.07



- Less then 0.2% dead channels
- Long term stability of amplitude (~5%) and timing (better than 1ns)
- MIP detection efficiency is > 99%
- No radiation aging up to well above 15fb^{-1}
- HV calibrated (< 10V)
- Signal amplitude stability checked with ^{90}Sr source (< few mV)

Form Muon Trigger and Cosmic Ray Veto

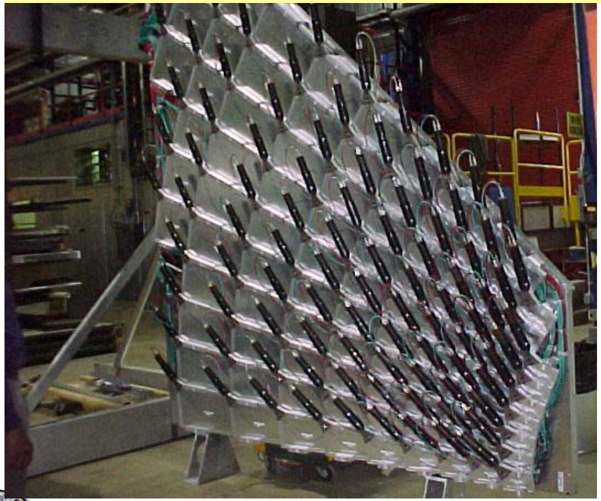
Forward Muon Detectors

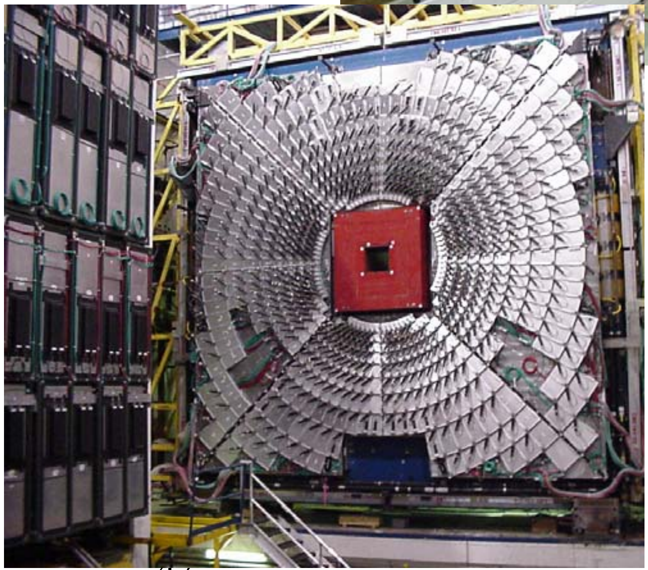
Forward muon truss
(supports C-layer detectors and shielding)

Forward mini drift tube detectors
(from JINR, Dubna, Russia)

1 cm × 1 cm
<0.4% bad

Forward muon trigger scintillators
(From Protvino, Russia)

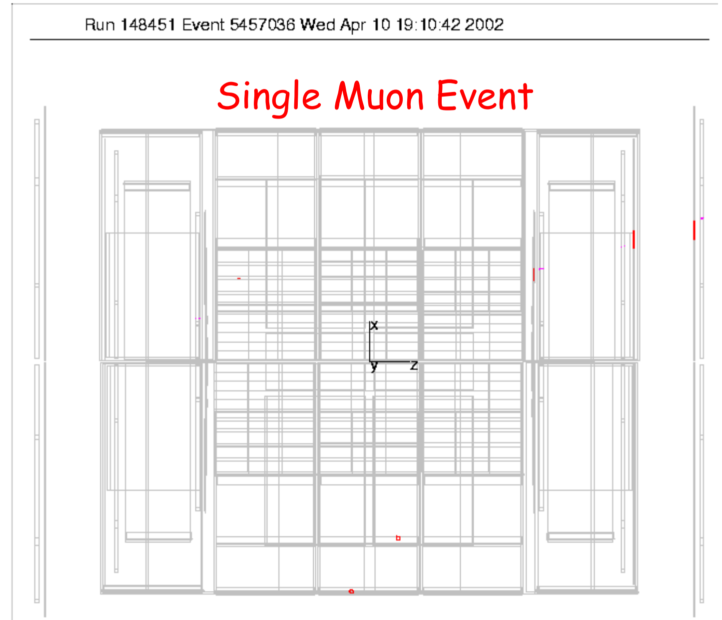


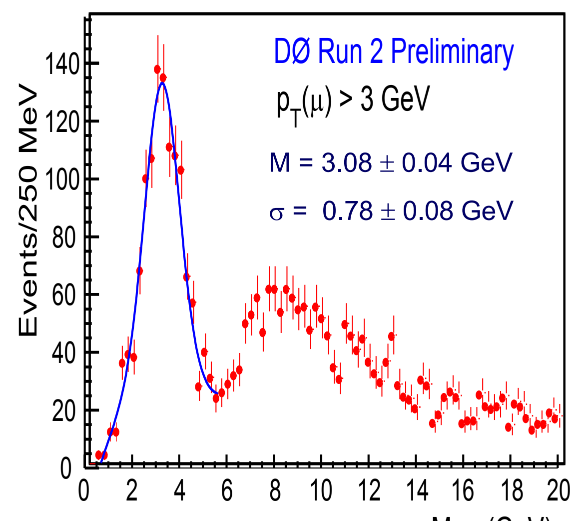


Mini drift tube
Plane and Pixels
(10m × 10m)

Forward Muon System Performance

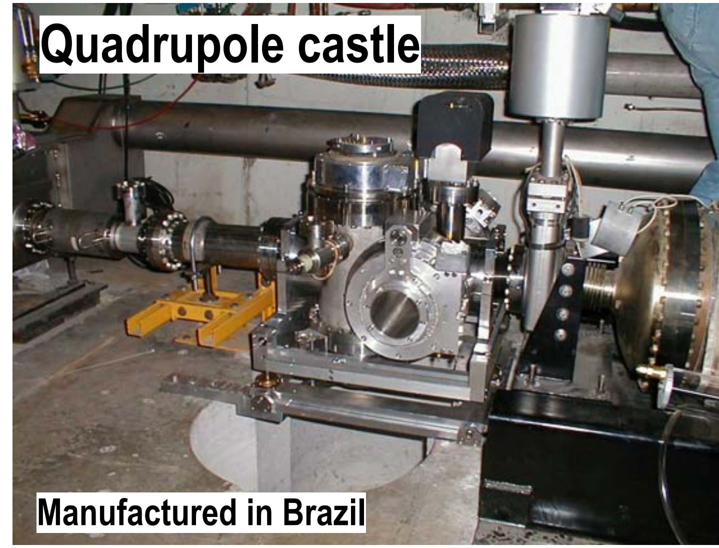
- Low occupancy of the forward muon detectors due to well designed shielding and use of fast detectors proved to be very low
  - at the 0.05%-0.1% level
  - simple and reliable muon triggering
    - after Level 1 trigger (scintillation counters only) 50% of events have good muon reconstructed off-line
    - after Level 2 trigger (mini-drift tubes and scintillation counters) 80% of events have good track reconstructed off-line
      - writing to tape background free samples
  - simple and background free muon off-line reconstruction

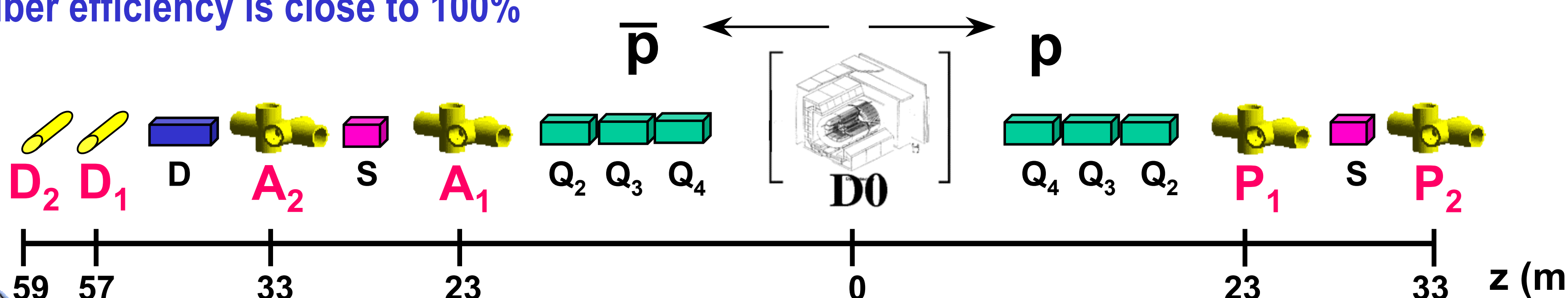




Forward Proton Detector

- Series of 18 Roman pots form 9 independent momentum spectrometers allowing measurement of proton momentum and angle
  - 1 Dipole spectrometer on pbar side
  - 8 Quadrupole spectrometers – U,D,L,R
- All castles installed + cabled + electronics
  - 10 fully instrumented
- Multiplexors allow the motion of 18 pots
- Initially readout through independent DAQ
- Integrating readout through AFE electronics and DØ DAQ
  - Rapidity gap + jet triggers added to DØ global list
- Fiber efficiency is close to 100%

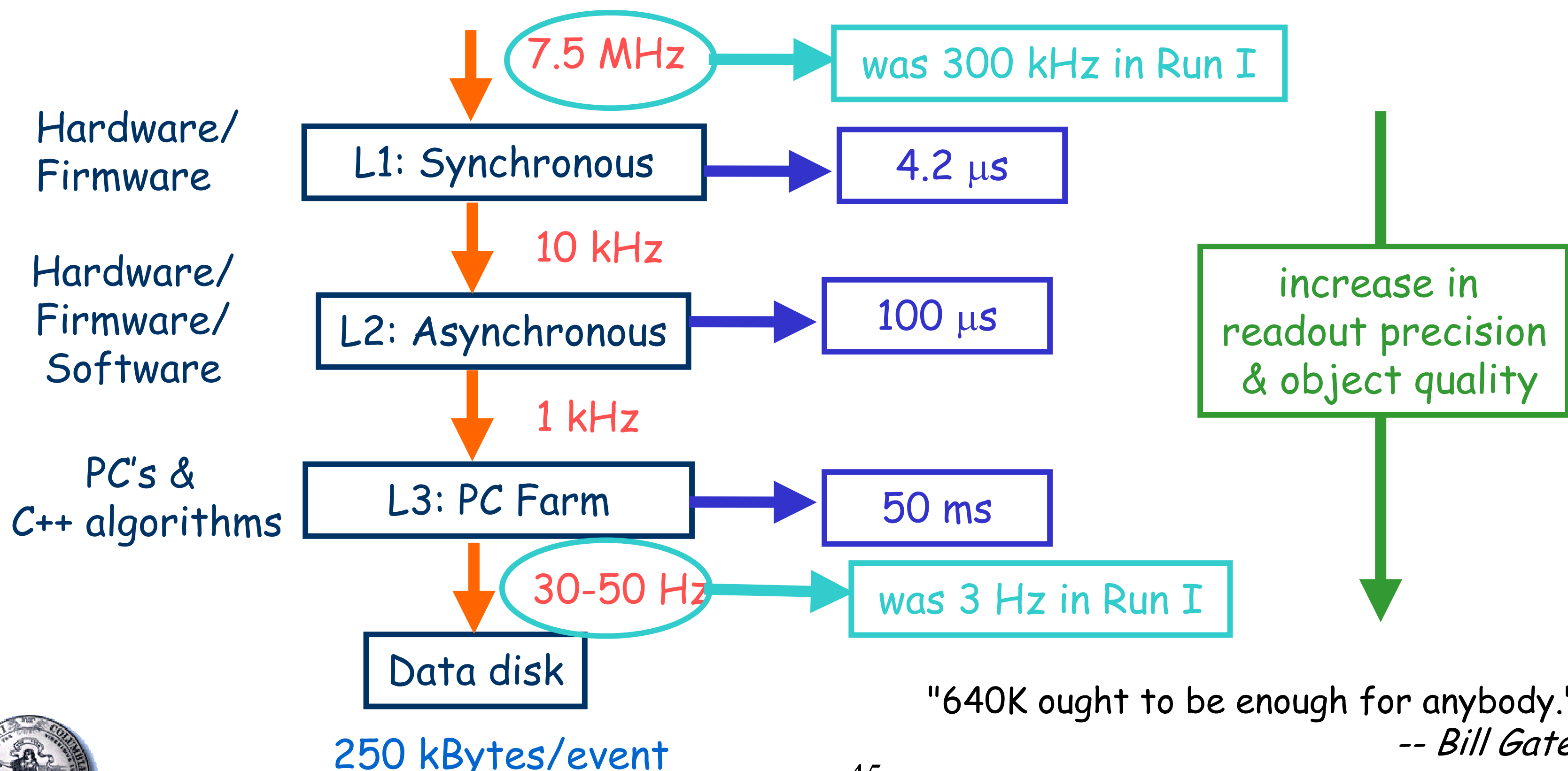




DØ Trigger Overview

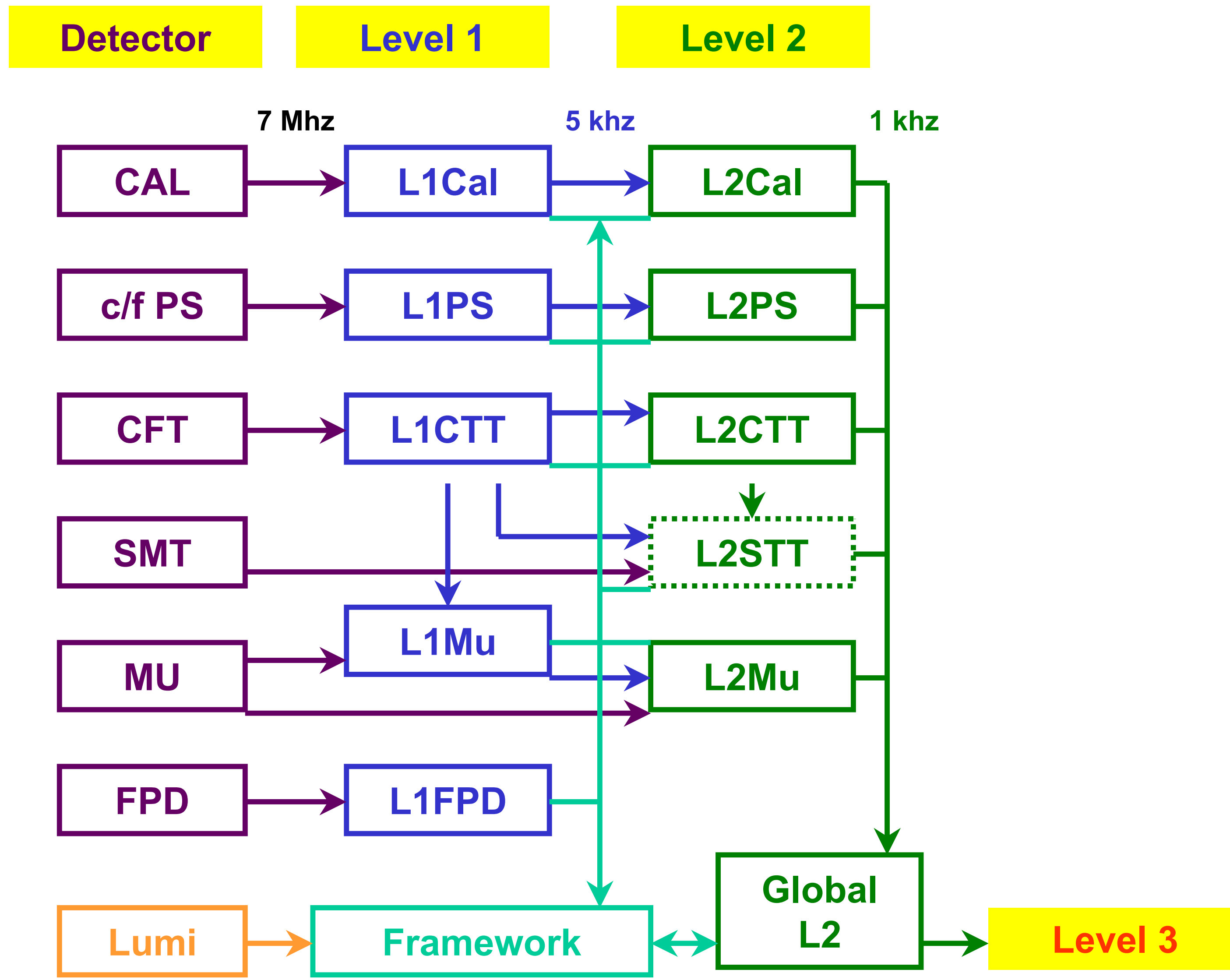
- There are 7.5M p-p crossings every second
- Huge data volume: 2 TB/sec – impossible to save all information on disk
- Focus on the "interesting" events: reduce data flow to 10-15 MB/sec
- Use modular system of three filtering levels

At $\mathcal{L} = 2 \times 10^{32}$ expect
4.4 W events/sec
5 $t\bar{t}$ events/hour and
7 W/ZH(100) events per day



"640K ought to be enough for anybody."
-- *Bill Gates, 1981.*

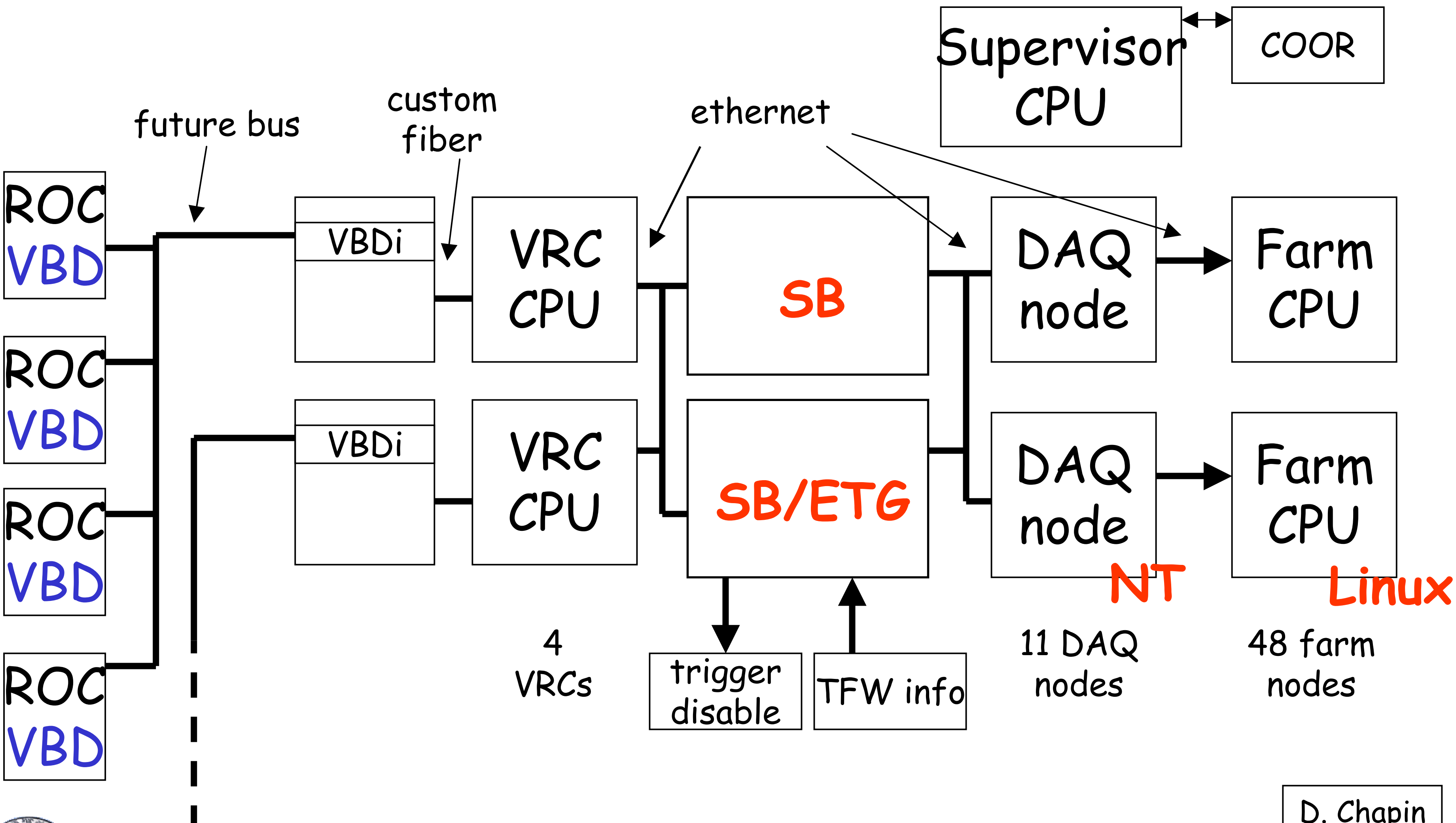
DØ L1 & L2 Triggers



Replaced L3/DAQ System

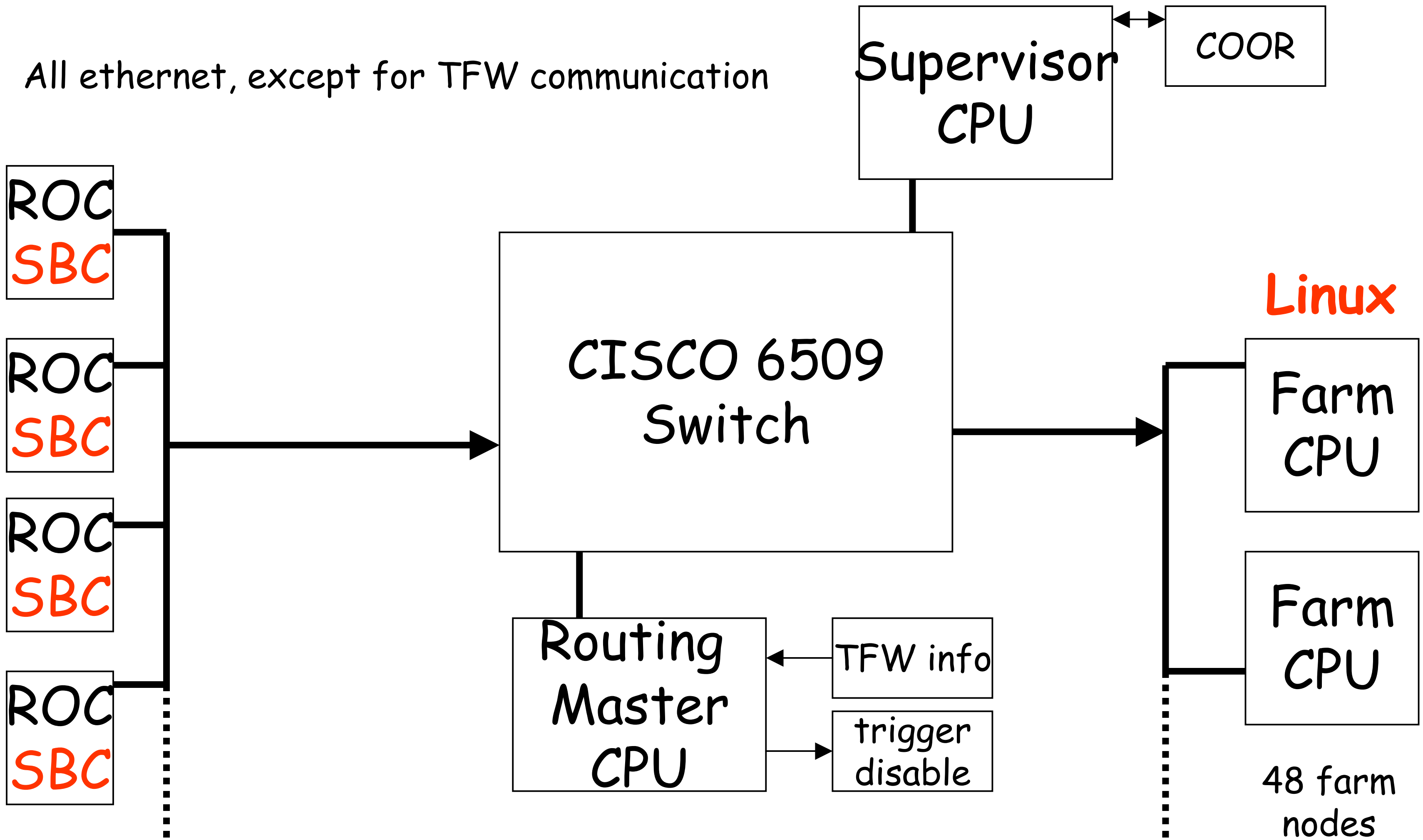
- **Early 2002 completely replaced the L3 DAQ system with commodity system based on Single Board Computers (SBCs) and fast Ethernet switches**
  - Previous system based on proprietary Run I VME Buffer Driver boards (VBD)
    - Vendor designed and manufactured chipset and boards way too late…
  - SBC
    - Intel ~1GHz, VME, dual 100Mb Ethernet, 64MB flash for storage, running Linux OS
    - essentially off the shelf hardware
  - Routing of data blocks performed by specialized SBC which talks to the Trigger Framework – the Routing Master (RM)
- **Event building and trigger L3NT nodes had been replaced earlier with Linux farm**
  - Too difficult to maintain Dzero code on NT platform for just this purpose
- **Truly adiabatic transition over a few months**
  - Completed by June 2002 – ahead of schedule!

Out with the Old



D. Chapin

In with the New



D. Chapin

Conclusions

- DØ detector has come a long way in the last couple of years
- Smooth operations with >85% livetime typically and design rate to tape
  - collect over 100k events/hour in good store
  - In first year of running used about 2/3 of luminosity for something, about 1/3 for "physics"
- Beam aborts and losses not an issue for D0 (unlike CDF)
  - Muon Shielding highly effective and fortuitous location
- All systems calibrated and well understood to zeroeth and first order
  - Second order tweaking ongoing
- Beam position stable
  - x-y (~10 microns) in a store, 30 microns in a week, z position with couple of cm
- Still need to integrate CTT fully, STT in the next few months and FPD
- Improving monitoring of data quality will allow reduction in shift load

Continued improvements and understanding of the detectors will directly impact the physics potential of the experiment